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JOURNAL OF THE COLLEGE OF AGRICULTURE
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University of the Philippines

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THE FIRST TECHNICAL MEETING ON POULTRY PRODUCTION IN ASIA AND THE FAR EAST [1]

F. M. FRONDA [2]

Eggs and poultry meat are now increasingly being recognized in Asia and the Far East as important sources of animal proteins which are essential in the human diet. Considering also the possibilities of developing poultry raising as a cottage industry, the Food and Agriculture Organization of the United Nations arranged for the holding of a technical meeting on poultry production in this region. Thus the First Technical Meeting on Poultry Production was convened in Poona, Bombay State, India, from October 17 to 27, 1955. India was wisely chosen as the seat of this first technical conference. It is the original home of the domestic fowl and has, at present, roughly one-eleventh of the total poultry population of the world.

OBJECTS OF THE MEETING

The objects of this technical meeting were the following:

1. To promote friendly interest and a better understanding of the problems of poultry production in Asia and the Far East by bringing together member countries of the Food and Agriculture Organization of the United Nations in this region on a common platform.

2. To pool the latest scientific knowledge and practical experience on the various aspects of successful poultry production.

3. To discuss various practical methods of improving and bringing about rapid scientific progress and expansion in all branches of poultry husbandry under the various climatic and other environmental conditions in Asia and the Far East.

4. To discuss the problems of poultry diseases and pests with a view to preventing losses.

5. To encourage the expansion and systematic development of scientific research and education necessary for the satisfactory development of the poultry industry in this region.

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[1] General Contribution No. 877.

[2] Research Professor of Poultry Husbandry. Official delegate of the Philippines to the meeting.

ORGANIZATION OF THE MEETING

The countries represented and the number of delegates were Cambodia, one, France, one, India, eleven, Philippines, two,[3] United Kingdom, two (Federation of Malaya, one, Singapore, one), and Vietnam, two. There were two observers from the United States and one representing the World's Poultry Science Association.

The preparations for the conference and the management of the services during the entire period were under the charge of an organizing committee designated by the Government of India. This committee was headed by Shri (Mr.) R. M. Patil, Poultry Development Officer, Poultry Institute, Kirkee, Poona, Bombay State, India.

Dr. R. L. Kaura, Cattle (and Poultry) Utilization Adviser to the Government of India, was elected by the conference as its Chairman, and I as its Vice-Chairman. Dr. H. Engler, Poultry Specialist, Animal Production Branch, Agriculture Division, Food and Agriculture Organization of the United Nations, Rome (Italy), served as Secretary of the meeting. He was assisted by Mr. J. E. Lancaster, Veterinary Officer, FAO Regional Office, Bangkok (Thailand), and Mr. F. Skaller, Officer-in-charge, C.S.I.R.O. Poultry Research Centre, Werribee, Victoria, Australia.

SUBJECTS DISCUSSED

The items on the conference agenda included the following:

a. Status and importance of the poultry industry, including statistics and estimates, in each country.

b. Improving poultry production through technical planning, cheaper housing, improved equipment, and better management.

c. Improving poultry production through breeding.

d. Improving poultry production through feeding.

e. Prevention of losses.

f. Improving institutions, services, and marketing.

From the information supplied by the delegates on the status of the poultry industry in their respective countries, it is obvious that much has still to be done before this industry can be considered to be on a par with the other agricultural industries. The demand for information on proper housing, breeding, feeding, management,

[3] The second delegate was Dr. T. M. Capulong, Assistant Chief, Poultry Division, Bureau of Animal Industry, who was in India on a cattle-buying mission for the Philippine Government. His request to attend this meeting was granted by the Minister of the Republic of the Philippines in New Delhi, India.

and prevention and control of losses through disease was common to all countries represented. My paper entitled "Types of laying houses for the farm" [4] attracted considerable attention and received highly favorable comments. There was unanimous agreement that upgrading, being an efficient method, should be used in transforming the indigenous poultry population of an area into a more productive one and that cross-breeding, including crisscrossing, should be employed to take advantage of heterosis. In this connection, I particularly drew attention to the necessity of culling unprofitable layers and emphasized the fact that success in any breeding operation depends on strict selection of the breeding stock.

The need for scientific studies on the nutritive value of poultry feeds, particularly those of indigenous origin, and on easily prepared formulae for balanced mashes making maximum use of farm and industrial waste products was brought to the fore. Special attention was also called to the necessity of using locally available feedstuff which is either not suitable or not required for human consumption.

Since losses in the poultry industry are largely prevented by good management, the attention of the delegates was called to the need for progressive education of all poultry raisers. Similarly, the importance of establishing adequate training facilities in all branches of poultry production, both on a scientific and a practical level, for research workers, poultry teachers, extension officers, and farm personnel was emphasized. It is recognized that the poultry industry, to develop along sound and profitable lines, should be continuously backed by scientific research in its various aspects.

SUMMARY OF RECOMMENDATIONS

At the close of each day's discussion, a committee composed of the Secretariat (the FAO staff and consultants) and the conference Chairman and Vice-Chairman sat down together to prepare recommendations. These recommendations were presented to the meeting for discussion and approval. Those approved were as follows:[5]

Importance of poultry production statistics and estimates

1. In view of the important contribution which utility breeds of poultry can make and the progress that can be obtained economically

[4] F. M. Fronda and A. C. Campos, *Philippine Agriculturist*, 39, 40 (1955).
[5] Taken from the draft report of the meeting furnished each delegate on the last day of the conference.

and in a relatively short time towards an improved human diet and increased income for the rural population of all countries, more emphasis should be given to the sound promotion of the poultry industry. For this purpose, more funds should be allocated by governments and nongovernmental bodies for the adequate development of this valuable industry according to the existing possibilities in each country.

2. Periodical sampling surveys on poultry number and production of eggs and meat should be carried out along the methods recommended by the Food and Agriculture Organization of the United Nations. This is considered an indispensable step for obtaining basic information and guidance for planning efficient activity on the government level, and later for evaluating the progress made.

Improving poultry production through technical planning, cheaper housing, improved equipment, and better management

1. In view of the fact that the plan and layout of a poultry unit, the type of houses and equipment, as well as the methods of management, influence the output and the economic results to a high degree, government and breeders' associations should pay full attention to this subject and issue suitable blueprints and leaflets. FAO may be requested by the governments concerned to assist countries in planning these proposals.

2. Poultry houses and equipment should be adapted to the local conditions and the materials available in the area in order to reduce capital outlay. In this connection prevention of diseases and safety from predatory animals must also be kept in mind. In tropical and subtropical countries, particular attention should be given to the proper protection of poultry from moisture, heat, and strong winds. Poultry houses should therefore be constructed to provide sufficient space, adequate protection from sun and rain, and efficient ventilation.

Improving poultry production through breeding

1. In order to replace the existing inferior flocks with more productive stock and in view of the fact that breeding is a relatively long-term project, it is essential that sound breeding programs on a national basis be formulated. Governments should arrange to carry out or to continue scientifically sound experiments to investigate the genetic potentialities of the indigenous breeds and the adaptability

of foreign breeds to the new climatic and other environmental conditions to which they will be subjected.

2. Considering the findings of these experiments, the foreign breeds approved for government improvement schemes should be limited to as few as possible. Recognizing the importance of improving the local types of chickens and ducks adapted to unfavorable environment and their possible merits as foundation stock, FAO should consider collecting information on this subject and preparing a special report.

3. Pure breeding should be encouraged on state and private breeding farms, mainly to obtain cockerels required for upgrading or crossbreeding in the rural areas. For this purpose fully equipped multiplication farms and hatcheries will be essential. Although individual selection based on trapnesting combined with family selection will give the quickest progress, family selection without individual recording is considered to be a more practical and economical system. Care should be taken to avoid inbreeding.

4. To transform the indigenous poultry population of an area into a more productive breed, upgrading should be practiced, being an efficient method. To take advantage of heterosis, crossbreeding, including crisscrossing, should be tried and if found successful, used instead of upgrading.

5. Preference should be given to random sample tests over the traditional egg laying competitions, as the former are considered superior in evaluating the viability and egg laying capacity of the breeder's flock. FAO should consider the preparation of basic principles and rules for random sample tests.

Improving poultry production through feeding

1. Governments should undertake scientific investigation on the digestibility and nutritional value of poultry feeds, particularly those balanced mashes that can be easily prepared and make maximum use of farm and industrial waste products. In this connection attention should also be paid to the use of locally available feedstuff which is either unsuitable or not required for human consumption.

2. FAO should consider the collection from countries in the region of information on poultry feedstuff of indigenous origin, including their chemical analysis and suitable formulae of compounded mashes for chickens and ducks, and the preparation of a document on this subject for distribution to the countries concerned.

3. Whenever and wherever possible, the manufacture and distribution of fish meal, meat meal, and other essential poultry feed supplements at reasonable prices should be encouraged by governments. The manufacture of commercial compound feed mashes for poultry should also be promoted both on a cooperative and a private basis.

4. In countries where commercial compound feeds are being manufactured, legal regulations, particularly on the standards of quality, should be introduced and the necessary analytical facilities made available by the governments. Close cooperation between the various countries of the region should be envisaged in order to standardize such regulations and analytical methods as far as possible.

Prevention of losses

1. Since the prevention of losses in the poultry industry is largely dependent on good management and the efficient control of infectious diseases, parasites, and predatory animals, increasing attention should be paid to the progressive education of all poultry raisers by the various government services.

2. Governments of countries in the region should extend the exchange of information on the control of poultry diseases which are important in the region and draw up sanitary and quarantine procedures, if not already in operation, to prevent the introduction of disease through the importation of eggs and poultry.

3. The prevention or control of infectious and parasitic diseases should be considered an essential part of any national scheme for the development of the poultry industry. Thus, an adequate disease investigation service is required. In addition, an adequate supply of safe and efficient biological and specific therapeutic agents should be made available either free or at subsidized rates. Sufficient trained personnel with the necessary transport facilities to carry out large-scale vaccinations and other related duties in the field should be provided by governments.

4. Laboratories engaged in the production of biologics for poultry should study the improvement of the safety and potency tests now in use. FAO, in cooperation with other specialized organizations, should consider the drafting of standard methods of production and testing of the various biological products for poultry in order that countries may adopt similar procedures, facilitating, if

necessary, the despatch of safe and efficient biologics from one country to another.

5. In view of the fact that in tropical and subtropical countries poultry may suffer or even die because of lack of proper transport facilities and that poultry products and feedstuff deteriorate rapidly in the absence of adequate processing, transport, and storage facilities, governments and the public should cooperate to effect improvements in this direction.

Improving institutions, services, and marketing

1. Governments should pay particular attention to the establishment of adequate training facilities in all branches of poultry production, both on a scientific and a practical level, for research workers, poultry teachers, extension officers, and farm personnel. For this purpose all agricultural and veterinary teaching institutions should have a well-equipped poultry farm for imparting practical training to the students. Postgraduate and refresher courses should also be organized at a central institution.

2. For successful development on sound and profitable lines the industry should be continuously backed by scientific research in its various aspects. Governments should therefore, as a part of their National Plan, undertake, assist, and coordinate research projects and exchange the results of research obtained in various centres within the country as well as in other countries of the region to make the most efficient use of the available funds, facilities, and scientific staff. FAO may be requested by governments concerned to assist countries in planning such work.

3. Assignment of FAO poultry experts to requesting countries should be for at least one or two years, and such experts should be invited to make follow-up visits at the appropriate time to assist in the implementation of their proposals. It is also desirable that the deputation of suitable personnel for training abroad be facilitated. The award of FAO fellowships should be for reasonably long periods and include adequate practical training.

4. In view of the importance of applying improved techniques to increase production and to improve the efficiency of production on a broad level, governments should make provision for an adequate extension staff, both at the headquarters and in the field, who should be in close contact with poultry research centres so that the rural

population can benefit from the present-day scientific knowledge in regard to proper management, breeding, and disease control. The establishment of demonstration units, distribution of leaflets, and holding of courses and lectures for poultry keepers, supported by visual aids, should form an essential part of an efficient extension service. Wherever possible, arrangements should also be made for giving popular lectures and demonstrations on poultry husbandry in the schools, and the formation of young farmers clubs should be encouraged.

5. National Poultry Improvement Plans should be regarded as a fundamental step in improving a country's poultry industry both on specialized farms and in villages. Such plans should be drawn up with a view to the stage of development of the country in general and its poultry industry in particualr.

6. Governments should assist in the development of adequate processing and organized marketing facilities and support measures to increase the consumption of poultry products. The establishment of marketing bodies, including cooperatives and national standards and grades for poultry products, should be encouraged with a view to improving as well as equalizing demand and supply. Facilities provided for this purpose should include cold storage. The provision of credit at low interest rates should also be envisaged.

7. Consideration should be given to the formation of a sub-group on poultry production, should FAO establish a permanent working party on livestock production in the Far East Region, in order to provide a continuing basis for consultation between the technical workers in the countries and the staff of FAO.

FIELD TRIPS AND ENTERTAINMENTS

The Committee on Arrangements, realizing the daily grind of attending a meeting of this nature, did not overlook provision in the program for some rest and relaxation. Appropriate field trips to places around Poona of possible interest to the different delegates were included in the agenda. Visits were made to the Government Poultry Farm at Kirkee, the Sheep and Wool Research Station at Bhamboorda, the National Chemical Laboratory at Pasham Camp, the Hindustan Antibiotics (Penicillin Factory) at Pimpri, the National Defence Academy and the Central Water and Power Commission Research Station at Kharkwasla, and several private poultry farms.

The entertainments that were provided included a garden party given by the Governor at the Government House on October 17 and one given by the Government of India on October 27; variety shows on October 18 and 26; and technical films on October 19, 22, and 24. A dinner party was given on October 21 by the Bombay State Poultry Association and another on October 25 by the Indian delegation.

The field trips and entertainments helped considerably in reducing monotony and fatigue. Indeed, the work involved in this First Technical Meeting on Poultry Production in Asia and the Far East was considerable. On the whole, the delegates never worked as hard as they did at this meeting. In spite of this, however, attendance at the conference was well worth the money spent, the energy utilized, and any inconvenience that the delegates might have experienced.

In addition, the All-India Cattle Show Committee organized for the occasion an All-India Poultry Show which was held from October 21 to 23. Many important breeds of poultry, including improved indigenous stocks, were exhibited. This show proved to be of real interest to the delegates and was, indeed, an excellent demonstration of the results so far achieved in the promotion and development of the poultry industry in India. It was inaugurated by Maj. Gen. E. Habibullah, Commandant of the National Defence Academy, himself a poultry raiser of long standing. Cash prizes, as well as silver loving cups of various sizes, were awarded. The prizes were distributed by Begum (Mrs.) Habibullah on the last day of the show.

THE NEXT MEETING

The delegates unanimously recommended that the Food and Agriculture Organization of the United Nations consider organizing a second regional meeting on this subject in 1958. There is no doubt that interest in poultry production is growing rapidly in Asia and the Far East. The second meeting will afford the delegates an excellent opportunity to discuss whatever progress was made and new problems that may have arisen in the meantime. Valuable contributions towards the development of the poultry industry were made at this first technical meeting. Funds and effort that will be spent by the participating governments in the second international technical meeting will be fully justified and will earn big dividends.

DORMANCY PERIODS OF PROMISING RICE VARIETIES[1]

MERCEDES R. BUENAVENTURA

WITH TWO TEXT FIGURES

In general, ordinary variations in daily mean temperature from September to January did not affect appreciably the germination of 46 of the 52 varieties studied. The dormancy periods of the varieties ranged from almost zero (Brondal Poetich) to 11 weeks (Tjahaya). Almost one-third of the varieties had a dormancy period of five weeks. Most of the varieties had a gradually rising average cumulative seedling emergence which appeared to be independent of the dormancy period.

Seeds of certain rice varieties when planted soon after harvest either fail to germinate or give very poor germination. After some time, however, samples taken from the same source usually give normal germination.

This dormancy period that often follows the period of maturity in rice has long been observed by farmers. Lord (1929) reported that the Maha rice variety in Ceylon has a rest period of two and a half months, but when harvested past its maturity, it has a short rest period or none at all. Chandraratna, Fernando, and Wattegedera (1952) found that dormancy in rice is related to photoperiodic reaction. In varieties insensitive to photoperiod, the dormancy period does not exceed six weeks; in most of the highly sensitive varieties, the period is longer.

So far, studies of this nature have been limited to foreign varieties. With so many varieties being raised on a commercial scale in the Philippines, the need for further information becomes more and more apparent. This study was therefore conducted from April, 1955, to February, 1956, to determine the rest period of promising rice varieties.

MATERIALS AND METHODS

Fifty-two promising upland and lowland varieties of rice which were included in the June planting of the Rice Observational Nur-

[1] Central Experiment Station Contribution No. 1877. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture, March, 1956. Prepared in the Department of Agronomy under the direction of Assistant Professor Pedro B. Escuro.

sery of the Division of Plant Breeding were used in this study. The varieties were harvested as soon as they matured, which was generally four to five weeks after heading. Where this rule was not applicable, the variety was considered ready for harvest when the upper portions of the panicles were uniformly yellow and the lowermost grains were in the hard dough stage.

The grains were threshed and separated from the chaff and straw in a head-thresher. They were immersed in a pan of water a number of times for about three minutes to separate further the well-filled grains from the improperly filled ones. The filled grains were then allowed to dry gradually until the moisture content was 14 per cent. They were dusted with a 5 per cent wettable DDT powder at the rate of 0.2 gram per 100 grams of grain, placed in paper bags, and finally stored in 5-gallon, air-tight containers provided with well-dried charcoal as dessicant.

Two sets of germination experiments were conducted. The 52 varieties were not tested at the same time because they matured at different periods.

Experiment 1. In experiment 1 the germination tests were carried out in two Mangelsdorf germinators. The temperature in one germinator was thermostatically controlled at 90°F., which is the optimum temperature for the germination of rice grain. In the other, the temperature varied with daily room temperature. A pan of water was placed at the bottom of each germinator to keep the humidity inside at the maximum.

There were two replications in each germinator. The varieties were randomly placed in each replication. Fifty seeds of each variety were distributed between folded water-soaked blotters. The blotters were sprinkled with water whenever excessive drying was noticed. From the time of harvest, germination tests were conducted at weekly intervals, and germination counts five days after. The tests were discontinued when the peak of germination had been attained for each variety.

Experiment 2. The experimental seedbeds were 1 meter wide and of any convenient length. There were four replications and as many plots in one replication as there were varieties tested. The plots were 1-meter rows spaced 40 centimeters apart. Only one planting was made. Fifty newly harvested and well-filled grains of each variety were counted and drilled in the row at uniform spaces and depths. The soil was kept sufficiently moist up to the end of the

experiment. The total number of seedlings that germinated was counted cumulatively at weekly intervals until the end of the study.

RESULTS AND DISCUSSION

Effects of controlled and uncontrolled temperature and humidity on germination. Slightly fluctuating temperatures ranging from 88° to 93°F. occurred in 40-minute cycles in the germinator used for controlled germination tests. The variations in temperature inside the other germinator were assumed to approach closely the daily mean temperatures during the study which were as follows:[2]

MONTH	TEMPERATURE RANGE (°F.)
September	77.6–84.3
October	77.6–83.4
November	72.4–81.8
December	73.2–79.0
January	74.2–81.0

The data on germination show that daily mean temperatures ranging from 72.4° to 84.3°F. and germinator temperatures varying from 88° to 93°F. failed to influence significantly the germination of 46 of the 52 varieties studied (table 1). Three varieties, Sinaguing, Cadedit, and Inintiw Strain 107, were significantly influenced unfavorably by high and fairly constant temperature and humidity.

Akemine (cited by Copeland, 1924) and Sousa (1942) showed that the optimum temperature for the germination of some tropical and semitropical varieties ranges from 30° to 35°C. (86° to 95°F.). These previous findings were not fully substantiated by the results of the present study. It is, however, worthwhile mentioning that the varieties tested in this study all belong to the *indica* group of *Oryza sativa Linn.* which is well-adapted to tropical regions.

Dormancy period. The dormancy period of a particular variety is assumed to have expired when the peak of germination is reached. Chandraratna, Fernando, and Wattegedera (1952) arbitrarily considered a germination of 80 per cent as marking the end of the dormancy period of any variety. In table 2 the upper figures, representing the percentage germination at weekly intervals, are the averages of four replications or the averages of the germination tests under controlled and uncontrolled temperature and humidity, unless

[2] Data from the College Weather Station.

otherwise indicated. There was no essential difference in percentage germination among the varieties under both germinating conditions. The percentage germination of those varieties that differed in germination when given different conditions was based on the average of two replications in the controlled test.

In table 2, the varieties are arranged in descending order of dormancy periods which were determined according to the method adopted by Chandraratna *et al.* The difficulty of comparing the germination of one variety with that of another variety tested at a later date or vice versa was solved by running a test for germination both under controlled and uncontrolled conditions. The fact that in 46 out of 52 varieties tested the temperature did not appreciably influence germination is sufficient evidence for the writer to assume that the data on germination of the varieties at a certain period after harvest, although obtained at different dates, are comparable.

A close examination of the data reveals that germination of most varieties rose fairly consistently until the peak, after which it tended to level off. This is rather unusual considering that the varieties used were not purified.

It is interesting to note that the rest period of the varieties ranged from almost zero (Brondal Poetich) to 11 weeks after harvest (Tjahaya). The dormancy period of the last eight varieties in table 2 had not yet ended at the conclusion of the experiment. Nevertheless, the presence of dormancy is evident from the data. The germination curves representing the extreme and average lengths of dormancy in varieties Tjahaya, Brondal Poetich, and Palawan are given in figure 1. The frequency distribution of the lengths of the dormancy periods of the varieties approximated a normal distribution with a mean of 4.93 $\pm$ 0.093 weeks:

Dormancy period (weeks)	1	2	3	4	5	6	7	8	9	10	11
Frequency	2	2	7	5	13	8	4	1	0	1	1

The lower figures in table 2 represent the average cumulative emergence of seedlings in the soil determined at weekly intervals. Close examination of the data reveals that there was a very gradual rise in average cumulative seedling emergence in most varieties from week to week. At the end of the experiment, no variety appeared to have reached its peak of seedling emergence. Apparently there was no close relationship between the average cumulative seedling

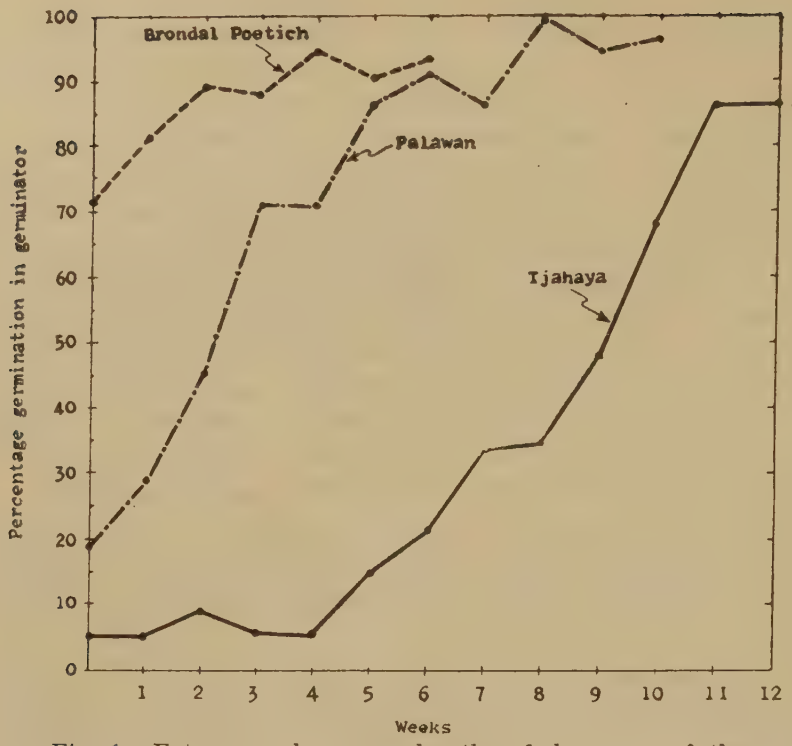

Fig. 1.—Extreme and average lengths of dormancy of three rice varieties.

emergence and the length of the dormancy period as determined by weekly germination tests. The curves for average cumulative seedling emergence of the varieties in figure 1 are given in figure 2.

These findings verify common field observations that grains left in the field after harvest may remain in the soil for a long period and may germinate any time as volunteer plants as soon as proper conditions for germination exist. These plants then become the principal sources of seed mixtures.

The trend of germination of rice in the soil is rather difficult to explain. The two factors essential to germination, proper temperature and sufficient moisture, were assumed to be essentially alike under both soil and germination conditions. Light has no influence on germination (Copeland, 1924). Likewise, oxygen has been shown by Overton and Pierce (cited by Copeland, 1924) and Taylor (1942) to have very little or no influence on germination. Certainly some other factors must be involved.

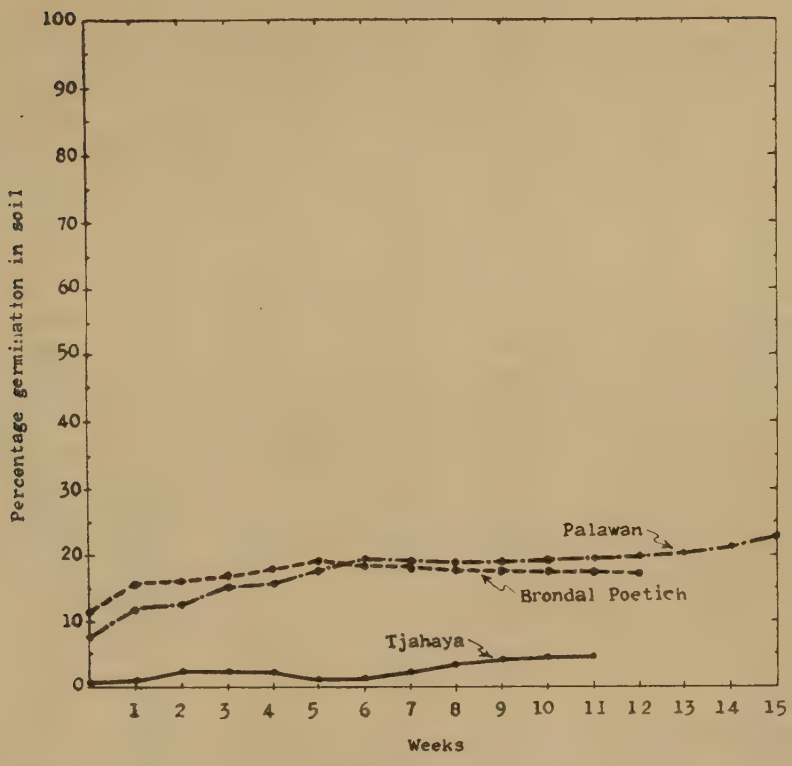

Fig. 2.—Cumulative percentages of seedling emergence of three rice varieties.

The dormancy period of certain varieties explains why such varieties, when planted in the field soon after harvest, either fail to germinate or give very poor germination. For high germination and good stand of plants, it is imperative that the dormancy period of the variety be known.

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TABLE 1.—*Mean difference of germination of rice varieties in germinator under controlled and uncontrolled temperature and humidity (based on average of 2 replications)*

VARIETY	SUM OF DIF.	n	MEAN DIFF. $C - U$	$\bar{s}_{\bar{x}d}$	COMPUTED t VALUE
Tjahaya	17	13	1.3	2.05	.634
Cadedit	—167	12	—13.9	2.83	4.911**
Nam Duk Mai	—73	10	—7.3	3.69	1.978
Macan I	31	9	3.4	3.18	1.069
Marabitwen	—91	12	—7.6	4.00	1.900
Sinaguing	—50	12	—4.2	1.30	3.230**
Azucena	27	12	2.2	2.39	.921
B 13 × 2	—9	9	—1	1.87	.534
Bulikayo	4	10	.4	4.19	.095
Dinorado	—25	10	—2.5	2.41	1.037
Inintiw Str. 107	—66	12	—5.5	1.66	3.313**
Kinandang Puti	50	11	5.4	1.88	2.872*
Milfor 6 (1)	3	12	.25	4.99	.050
Milfor 6 (2)	—9	12	—.8	5.29	.151
Salumpikit	45	11	4.1	3.61	1.135
Sulap	39	12	3.2	3.66	.874
Binicol	1	11	0.1	1.74	.057
Canoni	—4	11	.4	1.9	.211
Gendjah Benton (nb)	14	11	1.2	4.44	.270
Guinata	19	11	1.7	2.31	.736
Iola	28	11	2.5	1.84	1.358
Kinampupoy	17	10	1.7	2.31	.736
Lubang Puti	6	10	.6	1.09	.550
Makapilay Pusa	—41	12	—3.4	1.66	2.048
Magsanaya	17	11	1.5	1.84	.815
Palawan	—58	11	—5.2	2.63	1.977
Pinursigue	—18	10	—1.8	2.46	.713
Rexoro	—72	12	—6	2.83	2.120
Salak	20	11	1.8	2.49	.723
Catursa	—34	10	—3.4	2.14	1.588
Dinalaga	—17	7	—2.4	5.66	.424
Komayat	—32	10	—3.2	2.10	1.523
Mass Java	—120	11	—10.9	6.50	1.677
Capansa	22	9	2.4	1.74	1.379
Dourado Agulha	24	9	2.6	2.29	1.135
E.A.S. #3	18	10	1.8	2.97	.606
Fortuna	28	8	3.5	4.87	.718
Kinandang Nagpulot	20	8	2.5	2.36	1.059
Pac-ang	29	8	3.6	2.88	1.250
Portoc	—35	8	4.4	4.81	.915

TABLE 1 (continued)

VARIETY	SUM OF DIF.	n	MEAN DIFF. $C - U$	$\bar{s}\bar{x}\bar{d}$	COMPUTED t VALUE
Blue Bonnet	4	8	.5	1.48	.338
Gendjah Benton (b)	—17	10	—1.7	2.85	.596
Brondal Poetich	35	8	4.4	4.93	.892
Nagadhan	62	6	10.3	6.22	1.655
Apostol	—5	11	—.4	2.43	.164
Baiang	—51	13	3.9	2.77	1.408
Bulao	47	11	4.2	4.08	1.029
Dudk Kuning	—3	11	—.2	1.51	.132
Elon-elon B	—14	12	—1.2	1.28	.937
Khew Kao	—16	11	—1.4	2.09	.669
Skrimankote	38	13	2.9	1.15	2.522*
Nang Thay	51	9	5.6	1.43	3.916**

n—Number of pairs.
C—Controlled.
U—Uncontrolled.
$\bar{s}\bar{x}\bar{d}$—Standard error of the mean difference.
* Significant.
** Highly significant.

TABLE 2.—*Percentages of average germination in germinators and total germination in soil of rice varieties determined at weekly intervals* [a]

VARIETY P.O.G.[b]	WEEKS												ESTIMATE OF DORMANCY [c]
	0	1	2	3	4	5	6	7	8	9	10	11	
													weeks
Tjahaya	0.2	5.0	9.0	7.0	6.5	14.5	21.5	33.0	34.0	48.5	69.5	88.5	11
	0.2	0.2	1.5	1.5	1.5	1.5	1.5	1.5	2.5	2.5	3.0	4.0	
Cadedit [d]	5.0	13.0	14.0	18.0	21.0	35.0	58.0	51.0	55.0	61.0	87.0	89.0	10
	4.0	8.5	8.5	10.0	11.0	12.0	15.5	16.0	16.0	16.5	16.5	17.0	
Nam Duk Mai	0.2	1.0	3.0	3.5	8.0	27.0	51.0	75.0	87.5				8
	0	0	0	0	0.2	1.0	1.0	2.5	3.0	4.5			
Macan 1	5.5	16.5	18.0	20.0	35.0	45.0	53.0	81.0	82.5				7
	0	7.0	11.5	12.0	14.0	15.5	16.0	18.0	19.0				
Marabitwen	1.0	1.0	40.0	46.5	31.5	47.0	73.8	81.5	91.5	88.5	94.0	95.5	7
	0.2	0.2	7.0	7.5	7.5	7.5	7.5	9.5	10.5	10.5	11.0		
Sinaguing [d]	5.0	10.0	18.0	17.0	43.0	54.0	69.0	94.0	84.0	86.0	87.0	89.0	7
	2.0	9.0	10.5	10.5	10.5	10.5	10.5	10.5	11.0	11.5	11.5	11.5	
Azucena	30.5	32.0	45.5	40.0	64.5	75.5	93.5	94.5	92.5	98.0	98.5	99.5	6
	11.5	37.5	41.0	42.0	42.0	43.5	43.5	43.5	43.5	44.0	44.0	44.0	
B 13 × 2	1.5	3.0	3.5	10.0	67.0	74.5	88.5						6
	0	0	0	1.5	4.5	7.0	9.0	10.0	10.0				
Bulikayo	20.5	20.5	26.0	49.0	58.5	71.0	95.5	98.0	97.5	98.0			6
	7.0	23.5	32.0	36.5	39.5	40.5	42.0	42.0	43.0	43.0	43.0	43.0	
Dinorado	24.0	23.0	48.5	49.5	65.5	74.5	94.5	97.0	96.5	93.5			6
	7.0	26.5	31.0	32.5	32.5	33.0	33.0	33.0	33.0	33.0	33.0	33.0	
Inintiw Str. 107 [d]	5.0	10.0	18.0	28.0	37.0	50.0	78.0	93.0	94.0	93.0	93.0	99.0	7
	2.5	12.0	15.0	16.0	17.0	18.0	18.0	18.5	18.5	19.0	19.0	19.0	

TABLE 2 (continued)

VARIETY P.O.G.[b]	WEEKS												ESTIMATE OF DORMANCY [c]
	0	1	2	3	4	5	6	7	8	9	10	11	
													weeks
Milfor 6 (1)	10.5	27.0	35.5	44.5	40.5	59.5	81.0	69.5	78.5	72.5	92.5	90.5	6
	8.0	16.0	22.5	23.5	25.5	26.0	26.5	29.0	29.5	30.0	30.5	31.0	
Milfor 6 (2)	10.0	37.0	37.0	34.5	55.5	66.5	80.0	80.5	84.0	73.5	98.5	87.0	6
	7.5	16.5	19.5	20.5	21.0	21.0	21.5	23.5	23.5	24.0	24.5	24.5	
Salumpikit	39.0	38.0	60.0	66.0	77.0	68.5	93.5	90.5	95.0	96.5	89.5		6
	7.5	30.5	33.5	34.0	37.0	37.0	37.5	39.0	39.0	42.0	44.5	44.5	
Sulap	10.5	18.5	33.0	37.0	35.5	64.0	94.5	83.0	91.0	98.0	91.0	97.5	6
	7.0	21.5	24.0	27.5	28.0	28.0	28.5	29.5	29.5	29.5	29.5	29.5	
Binicol	17.0	42.0	46.5	56.0	74.5	90.5	94.0	97.5	99.0	99.6	97.0		5
	3.5	19.0	26.5	27.0	27.0	28.0	29.5	30.5	31.0	32.0	33.5	34.0	
Canoni	15.0	25.5	27.5	67.0	65.5	82.0	93.5	89.0	87.5	89.0	93.5		5
	15.5	21.0	22.5	23.5	23.5	26.0	26.5	28.0	28.5	28.5	28.5	28.5	
G. Benton (nb)	30.5	45.5	59.0	63.5	67.0	85.0	79.5	83.5	81.5	96.0	97.0		5
	15.5	23.5	25.0	25.0	25.5	25.5	27.0	27.0	27.0	27.5	29.0	29.5	
Guinata	34.5	69.0	64.5	60.0	78.0	89.5	95.0	94.0	94.5	98.5	96.0		5
	12.0	38.5	46.5	46.5	48.0	49.0	49.0	49.0	49.5	51.0	51.5	52.0	
Iola	17.5	26.0	31.0	71.5	60.0	93.5	89.0	89.5	94.0	95.0	95.0		5
	23.5	31.0	32.5	35.0	36.0	37.0	37.5	39.0	39.5	39.5	39.5	39.5	
Kinampupoy	1.0	14.0	23.5	38.0	78.5	90.5	96.5	99.0	95.0	99.5			5
	3.0	5.0	5.0	5.0	5.0	5.5	6.0	6.0	6.0	6.0	6.0	6.5	
Lubang Puti	7.0	29.5	35.0	47.0	72.5	91.5	93.5	94.5	95.0	96.5			5
	6.0	13.5	13.5	17.0	17.0	17.5	18.0	18.0	18.0	18.0	18.0	18.5	
Makapilay Pusa	4.5	11.5	15.0	37.0	30.5	93.5	96.5	95.0	95.5	85.0	98.5	99.0	5
	13.5	17.0	20.0	21.5	21.5	21.5	22.5	24.5	26.5	33.5	36.0	36.5	

TABLE 2 (continued)

VARIETY P.O.G.[b]	WEEKS												ESTIMATE OF DORMANCY [c]
	0	1	2	3	4	5	6	7	8	9	10	11	
													weeks
Magsanaya	43.5	51.0	60.5	72.5	68.0	91.5	94.5	95.0	95.0	98.0	95.5		5
	13.5	36.5	31.0	42.0	42.0	43.0	44.0	45.5	45.5	46.0	46.0	46.0	
Palawan [d]	13.0	28.0	44.0	76.0	74.0	86.0	91.0	80.0	97.0	86.0	86.0		5
	9.0	11.5	13.0	13.0	15.0	16.0	17.0	18.5	18.5	19.0	19.0	19.0	
Pinursigue	11.5	19.5	30.5	35.0	54.0	85.0	95.0	98.0	90.5	98.0			5
	11.0	26.5	27.0	28.0	28.0	30.5	31.0	32.5	34.0	34.5	35.0	35.5	
Rexoro	9.0	20.5	27.0	75.0	56.0	89.0	88.0	75.0	92.0	83.5	97.0	97.0	5
	10.5	18.0	20.5	22.5	24.5	26.0	26.0	26.5	26.5	26.5	26.5	26.5	
Salak	8.0	95.0	42.5	72.5	70.0	82.0	86.0	74.5	86.5	96.5	93.5		5
	7.5	9.5	14.0	15.0	15.0	16.0	20.0	20.0	20.5	20.5	20.5	20.5	
Catursa	6.0	21.0	58.0	60.0	30.5	91.0	97.0	96.5	94.5	94.5			4
	3.0	6.5	10.0	12.0	12.0	12.0	14.5	14.5	14.5	15.5	16.0	16.5	
Dinalaga	29.0	29.0	31.0	78.5	86.0	95.0	97.5	98.0	99.0				4
	19.0	30.0	33.5	36.0	38.0	38.5	38.5	39.0	39.0	39.0	39.0	39.0	
K. Puti [d]	49.0	58.0	69.0	70.0	81.0	75.0	94.0	95.5	98.0	98.0	99.0		4
	15.0	38.5	48.0	48.5	49.5	51.0	52.0	54.0	54.5	55.5	56.0	56.0	
Komayat	30.0	37.0	45.0	66.5	93.0	94.0	98.0	96.5	96.5	98.0			4
	16.0	42.5	44.5	45.0	45.5	46.0	46.0	46.0	46.0	46.0	46.0	46.0	
Mass Java	7.0	32.5	66.0	65.5	83.5	89.0	97.0	88.0	82.0	96.5	97.0		4
	4.5	9.0	11.5	15.0	15.0	16.0	16.0	16.0	16.5	16.5	16.5	17.5	
Capansa	9.0	25.0	43.0	89.5	91.0	99.5	99.5	95.0	97.5				3
	11.5	19.5	25.5	26.5	27.5	29.0	29.5	29.5	29.5	30.0	30.5	30.5	
Dourado Agulha	51.0	52.5	76.5	81.0	89.0	95.5	95.5	94.0	96.0				3
	10.5	48.0	54.0	55.0	55.0	55.0	55.5	55.5	55.5	55.5	55.5	55.5	

TABLE 2 (continued)

VARIETY P.O.G.[b]	WEEKS											ESTIMATE OF DORMANCY [c]
	0	1	2	3	4	5	6	7	8	9	10	11	*weeks*
E.A.S. #3	68.0	63.5	75.5	84.0	95.0	95.5	96.5	96.5	95.0	94.5	93.5		3
	40.5	54.0	57.0	57.0	57.0	57.0	57.0	57.0	57.0	57.5	57.5	57.5	
Fortuna	29.5	40.0	61.5	88.5	97.0	98.5	98.5	99.5					3
	25.0	44.0	36.0	36.0	36.0	36.0	37.0	37.5	37.5	37.5	37.5	37.5	
K. Nagpulot	32.0	57.0	68.0	97.0	93.0	96.5	99.5	98.0					3
	40.5	46.5	48.5	48.5	49.0	49.0	49.0	49.0	49.0	49.0	49.0	49.0	
Pac-ang	47.5	65.0	76.0	86.5	92.5	96.0	94.5	91.5					3
	6.0	15.5	16.0	16.5	18.0	19.0	19.0	19.5	20.0	20.0	20.0	20.5	
Portoc	39.5	65.0	71.0	96.5	94.5	97.0	100.0	100.0					3
	24.0	37.5	40.5	44.5	48.0	49.0	49.5	50.0	50.0	51.0	51.0	51.5	
Blue Bonnet	30.5	56.0	80.0	96.5	99.5	97.0	97.5	99.0					2
	34.5	42.0	44.5	48.0	49.5	50.5	50.5	51.5	51.5	52.0	52.0	52.0	
G. Benton (b)	48.5	51.0	95.5	60.5	79.0	88.0	97.5	90.0	87.5	90.5			2
	18.0	26.0	30.0	32.0	32.5	32.5	32.5	33.0	33.0	33.0	33.0	33.0	
Brondal Poetich	77.0	82.0	90.5	89.5	95.0	91.0	97.0	93.0					1
	12.0	15.0	16.5	17.0	17.0	17.0	17.0	17.0	17.0	18.5	18.5	18.5	
Nagadhan	59.5	96.0	87.0	99.0	98.0	95.0							1
	11.0	20.5	23.0	23.0	23.0	23.0	23.0	23.0	23.5	24.0	24.0	24.0	
Apostol	7.0	10.0	6.5	6.5	6.5	25.0	10.5	28.0	33.0	57.5	58.0		
	0	4.5	5.0	5.0	5.5	5.5	5.5	6.5	6.5	8.5	9.5		
Baiang	8.0	—	20.0	20.0	28.5	36.5	40.5	57.0	53.0	66.0	60.0	72.5	
	3.0	3.0	3.5	6.5	7.5	7.5	7.5	7.5	8.0	8.5	9.0	10.0	
Balao	3.0	4.0	4.5	3.5	8.0	17.0	12.0	22.5	42.5	74.0	75.5		
	0.2	1.5	1.5	1.5	2.0	2.5	3.0	3.0	3.5	3.5	3.5		

TABLE 2 (continued)

VARIETY P.O.G.[b]	WEEKS												ESTIMATE OF DORMANCY [c]
	0	1	2	3	4	5	6	7	8	9	10	11	
													weeks
Dudk Kuning	1.5	9.5	7.0	5.0	7.5	6.5	13.0	13.5	9.0	13.5	14.0		
	0.5	1.5	3.0	3.0	3.0	3.0	3.5	4.5	4.5	6.0	6.5		
Elon-elon B	0.5	0	3.0	1.5	4.5	8.0	7.0	7.0	23.5	36.5	71.0	59.5	
	0	0.5	2.0	2.0	2.5	3.0	4.0	5.0	5.5	5.5	5.5	6.5	
Khew Khao	3.5	4.0	4.5	4.0	5.5	5.0	7.0	22.0	28.0	49.5			
	1.5	5.5	5.5	6.0	6.0	6.0	7.0	8.0	8.5	8.5	8.5		
Skrimankote [d]	4.0	6.0	3.0	4.0	3.0	12.0	13.0	8.0	9.0	17.0	14.0	26.0	
	0.8	1.0	2.5	2.5	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	
Nang Thay	2.0	11.0	8.0	15.0	24.5	24.5	49.5	66.0	75.5				
	0.5	0.5	1.0	1.0	2.5	3.5	3.5	4.0	4.0				

[a] Based on average of four replications unless otherwise indicated.
[b] Place of germination. Upper figures, germination in Mangelsdorf germinators; lower figures, in seedbed.
[c] Dormancy period was assumed to have ended when a germination of 80 per cent was attained.
[d] Germination in germinator was based on average of two replications under controlled conditions.

NODULE BACTERIA OF PHASEOLUS AUREUS AND PHASEOLUS CALCARATUS [1]

VIVENCIO L. QUIÑON and NERIUS I. ROPEROS

Six isolates of mungo nodule bacteria and five of tapilan nodule bacteria proved effective in increasing nitrogen content of the plants and inducing development of nodules. All inoculated plants gave greater amounts of nitrogen in both sterilized and unsterilized soils.

Nodules first appeared as minute, white, round protrusions on the tap roots 9 to 15 days after inoculation of the sprouted seeds on Bryan's modified Crone's agar.

The bacteria were rod-shaped with rounded ends when young and coccoid when older. The average size of the mungo bacteria was 1.68 by .69 microns; that of the tapilan nodule bacteria was 1.57 by .73 microns. The colonies which developed on plated yeast-extract mannitol agar were raised, moist, circular, finely granular, with entire edges.

The organisms grew very abundantly on yeast-extract mannitol agar slants, yeast-extract glucose broth, and yeast-extract glucose agar. Nutrient agar, nutrient broth, nutrient gelatin, and potato plugs were of no cultural significance. No serum zone formation was observed on litmus milk.

The irregular nature of the variations in physiological characters of the isolates did not warrant correlation of any kind.

The mere presence of nodules on legumes does not insure beneficial effects to the plants. Hughes, Heath, and Metcalfe (1951) cited Allen as stating that low yields and even crop failures may be due to the nodulation of legumes by poor types of rhizobia. Effective strains of rhizobia cause the formation of large pink nodules on the root system and the fixation of large amounts of free nitrogen. On the other hand, certain strains cause the formation of numerous small, white nodules. These are the undesirable rhizobia which bring about the fixation of little, if any, atmospheric nitrogen.

From December, 1953, to October, 1955, effective strains of bacteria of mungo (*Phaseolus aureus* Roxb.) and tapilan (*Phaseolus calcaratus* Roxb.) were isolated and studied as to morphological, cul-

[1] Central Experiment Station Contribution No. 1878. Based on theses presented by the authors for graduation with the degree of Bachelor of Science in Agriculture in 1955. Prepared in the Department of Plant Pathology under the direction of Dr. F. T. Orillo and Mr. William L. Fernandez.

tural, and physiological characteristics for possible use in legume inoculation.

THE ROOT NODULE ORGANISMS

Isolation to pure culture

The cultures of nodule bacteria were isolated from the nodules of mungo and tapilan essentially by the method of Fred, Whiting, and Hastings (1926), except that the concentration of mercuric bichloride was reduced to 1:1000. The stock isolates were maintained in yeast-extract mannitol agar slants prepared according to the method of Allen and Baldwin (1931). The purity of the cultures was confirmed by repeated platings with 1:40,000 congo red dye.

Testing cultures for nodule production

The isolates were tested for nodule production of Bryan's modified Crone's agar medium prepared according to Carroll (1934). One-liter Erlenmeyer flasks were filled with 700 ml. each of the medium. The flasks were plugged with cotton provided with tubes with cut-off bottoms to guide the plants as they emerged. Then they were autoclaved at 121°C. and under 15 pounds pressure for one hour and placed in paper bags to prevent direct exposure to sunlight.

The seeds were disinfected with mercuric bichloride (1:1000) for three minutes and rinsed six times with sterile distilled water. Completeness of sterilization was confirmed by planting the seeds in previously plated 1 per cent nutrient agar and incubating for 24 to 48 hours. Three to four sprouting seeds were planted in each flask aseptically, and duplicate flasks were maintained for each isolate. Two controls each were provided: one uninoculated and the other inoculated with crushed nodule. The inoculum was applied as bacterial suspension. Daily observations were made for first signs of nodule formation.

In the two trials, seven mungo isolates and only five of the original ten tapilan isolates produced nodules. The uninoculated controls were free from nodules, and the inoculated controls had nodules. The nodules first appeared as minute, white, round protrusions on the tap roots 9 to 15 days after inoculation. All ineffective isolates were discarded. The isolates of mungo were numbered 1, 2, 5, CN 1, CN 2, CN 3, and CN 4; those of tapilan were designated as T11, T12, T13, T51, and T52.

Nitrogen fixation capacity of the isolates

The isolates were tested for nitrogen fixation capacity in sterilized and unsterilized potted sandy soils.

For the mungo isolates, 24 pots were filled with soil and autoclaved for five hours at 121°C. and at 15 pounds pressure. Three pots of sterilized soil and one pot of unsterilized soil were maintained for each isolate.

For the tapilan isolates, 12 pots were filled with soil and autoclaved for four hours. Another 12 pots were not autoclaved. Two pots of sterilized soil and another two of unsterilized soil were maintained for each isolate. Four control pots were maintained: two in the sterilized soil and two in the unsterilized.

The seeds were first disinfected with 1:1000 mercuric bichloride, dipped three to six minutes in 95 per cent alcohol to remove the mercuric bichloride, and fiinally rinsed six times with sterile distilled water. Seven to ten seeds were planted in each pot. Heavy bacterial suspensions of 48-hour-old cultures of the isolates in yeast-extract mannitol agar slants were poured over the seeds before they were covered with soil. Sterile water was poured instead on the controls.

Six weeks after planting, the plants with their whole root systems were carefully pulled from the soil. Composite samples of the cultures in sterilized soil consisted of seven to eight plants picked at random, and those in unsterilized soil, five to eight plants. The nodules were counted and the dry weight of each plant was obtained. Then the nitrogen content of each plant was determined by the Kjeldahl method (AOAC, 1950). Two determinations were made for each composite sample.

All inoculated tapilan plants gave more nitrogen than the controls in both sterilized and unsterilized soils (tables 1 and 2). The increase in nitrogen content ranged from 6.0 mg. to 18.3 mg. in the sterilized soil and 4.9 mg. to 28.4 mg. in the unsterilized soil.

Except for mungo isolate CN 1, all inoculated mungo plants also gave more fixed nitrogen than the controls (tables 1 and 2). The increase in nitrogen content ranged from 0.0 mg. to 13.8 mg. in the sterilized soil and 1.2 mg. to 9.8 mg. in the unsterilized soil.

Morphology of the isolates

Microscopic examination of 48-hour-old cultures of the mungo and tapilan nodule bacteria showed that the cells were rod-shaped

TABLE 1.—*Nitrogen fixation and nodulation of mungo and tapilan plants in sterilized soil*

ISOLATE	DRY WEIGHT OF A PLANT	NUMBER OF NODULES TO A PLANT	TOTAL NITROGEN IN PLANT	NITROGEN FIXED TO A PLANT	NITROGEN FIXED OVER CONTROL
	mg.		%	*mg.*	*mg.*
Mungo:					
1	746.6	17.7	3.5	26.1	13.6
2	709.1	12.8	3.3	23.4	10.9
5	796.8	17.8	3.3	26.3	13.8
CN 1	430.8	10.7	2.9	12.5	0.0
CN 2	617.7	16.1	3.0	18.5	6.0
CN 3	730.0	14.1	3.1	22.6	10.1
CN 4	666.8	15.0	3.2	21.3	8.8
Control	430.7	—	2.0	12.5	
Tapilan:					
T11	1,320.0	35.1	4.0	52.8	18.2
T12	1,330.0	30.0	3.8	50.5	15.9
T31	1,260.0	45.5	4.2	52.9	18.3
T51	1,040.0	27.1	3.8	40.6	6.0
T52	1,380.0	26.7	3.5	48.3	13.7
Control	1,080.0	—	3.2	34.6	—

TABLE 2.—*Nitrogen fixation and nodulation of mungo and tapilan plants in unsterilized soil*

ISOLATE	DRY WEIGHT OF A PLANT	NUMBER OF NODULES TO A PLANT	TOTAL NITROGEN IN PLANT	NITROGEN FIXED TO A PLANT	NITROGEN FIXED OVER CONTROL
	mg.		%	*mg.*	*mg.*
Mungo:					
1	625.8	12.8	3.3	20.6	6.7
2	590.7	16.8	3.5	20.7	6.8
5	742.2	14.2	3.2	23.7	9.8
CN 1	522.5	9.2	2.9	15.1	1.2
CN 2	562.3	11.2	3.2	17.9	4.0
CN 3	694.8	10.2	3.1	21.5	7.6
CN 4	692.8	9.6	3.5	22.9	9.0
Control	480.4	1.4	2.9	13.9	
Tapilan:					
T11	1,490.0	37.5	4.1	61.1	26.1
T12	1,170.0	28.5	3.9	45.6	10.6
T31	1,510.0	27.8	4.2	63.4	28.4
T51	1,350.0	25.1	3.8	51.3	16.3
T52	1,110.0	24.3	3.6	39.9	4.9
Control	1,060.0	17.3	3.3	35.0	—

with rounded ends. In two- to three-week-old cultures the cells had become coccoid. Aquino and Madamba (1939) attributed this change to the pleomorphic nature of the rhizobia as found by earlier workers.

Two hundred cells from the mungo bacteria cultures measured 1.35 to 2.34 by 0.45 to 0.90 microns; the average was 1.68 by .69 microns. The same number of cells from the tapilan bacteria cultures ranged from 1.27 to 1.98 by 0.51 to 0.94 microns; the average was 1.57 by 0.73 microns.

Cultural characteristics

Yeast-extract mannitol agar. Growth on this medium was raised, echinulate, glistening, slimy, and abundant.

Nutrient gelatin. Stab cultures showed very poor growth confined mainly to the surface. Tapilan isolate T12 liquefied the medium five days after inoculation, but in the rest of the cultures there was no liquefaction even after six weeks.

Nutrient broth. The isolates grew very poorly on this medium.

Nutrient agar slant. Growth was dry and flat and very poor on this medium.

Litmus milk. No serum zone formation was observed after six weeks of incubation.

Potato plugs. None of the isolates grew on this medium except mungo isolate CN 4 which showed a slight growth. *Agrobacterium radiobacter,* a regular contaminant in the isolation of nodule bacteria, gives a brownish or grayish growth. Isolate CN 4 did not give such a growth.

Yeast-extract glucose broth. Vigorous growth was observed on this medium as shown by heavy turbidity with very slight pellicle formation after two weeks of incubation.

Yeast-extract glucose agar. The growth of the isolates on this medium was raised, abundant, and glistening.

Plate colonies. On yeast-extract mannitol agar, the colonies were circular, raised, smooth, moist, finely granular, with entire edges. After one week of inoculation at 28°C. the diameters of the mungo colonies ranged from 2 mm. to 4 mm., and those of the tapilan colonies, 1.84 to 3.90 mm.

Physiology of the cultures

Resistance to crystal violet. To classify the isolates according to their tolerance of crystal violet, Buchanan's peptone sucrose solu-

tion at pH 7.0 was used (Stevens, 1925). The solution was from 1:5,000 to 1:100,000 in concentration.

The cultures were incubated at 28°C. for two weeks. Transfers were made from them to yeast-extract mannitol agar. The solutions without the dye served as controls. Observations were made daily.

Fred, Whiting, and Hastings (1926) observed that the limiting concentration of crystal violet for the cowpea nodule bacteria group, to which mungo and tapilan nodule bacteria belong, was 1:25,000. Mungo isolates 1, 2, 5, CN 1, and CN 2 tolerated crystal violet at 1:25,000 concentration (table 3). Isolate 1 tolerated a concentration as high as 1:20,000. Tapilan isolates T11 and T31 tolerated a concentration as high as 1:15,000.

Reduction of indigo carmine and methylene blue. Although it has been observed that nodule bacteria, in general, exhibit only a weak reducing power, Gaw (1944) reported that Muller and Stapp found indigo carmine to be reduced by all strains, and methylene blue only by fast-growing strains. He also reported that Fred showed methylene blue to be reduced by bacteria of the cowpea group to which mungo and tapilan nodule bacteria belong.

In this study, culture medium was prepared according to the method of Fred, Baldwin, and McCoy (1932). The inoculated cultures were incubated at 27° to 28°C. and observed daily for two weeks.

Table 4 shows that all mungo isolates reduced the 1:250,000 concentration of indigo carmine and methylene blue. With the exception of CN 1, all cultures reduced the 1:50,000 concentration of indigo carmine. Only mungo isolates 2, CN 2, and CN 4 reduced the 1:50,000 concentration of methylene blue.

The five isolates of the tapilan nodule bacteria were able to reduce indigo carmine at concentrations of 1:50,000 and 1:250,000. Isolate T51 failed to reduce methylene blue at the same concentrations.

Gum production. Legume bacteria have been observed to produce considerable slime when grown on a suitable culture medium (Wright, 1925). The mungo and tapilan isolates were separately inoculated on Buchanan's peptone sucrose solution. Erlenmeyer flasks with 100 ml. each of the medium at pH 7.0 were autoclaved for 15 minutes at 121°C. and at 15 pounds pressure. After cooling, each of the flasks was inoculated with one loopful of a 48-hour-

TABLE 3.—*Tolerance to crystal violet of mungo and tapilan nodule bacteria*

CONCENTRATION OF CRYSTAL VIOLET	MUNGO ISOLATES							TAPILAN ISOLATES				
	1	2	5	CN 1	CN 2	CN 3	CN 4	T11	T12	T31	T51	T52
1:5,000	—	—	—	—	—	—	—	—	—	—	—	—
1:10,000	—	—	—	—	—	—	—	—	—	—	—	—
1:15,000	—	—	—	—	—	—	—	+	—	+	—	—
1:20,000	+	—	—	—	—	—	—	+	—	+	—	—
1:25,000	++	+	+	+	+	—	—	++	+	++	+	+
1:30,000	+++	++	++	++	++	+	+	++	++	+++	++	++
1:40,000	+++	+++	+++	+++	+++	++	++	+++	+++	+++	+++	+++
1:50,000	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
1:75,000	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
1:100,000	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++
Control	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++

— No growth; + slight growth; ++ moderate growth; +++ good growth.

TABLE 4.—*Reduction of methylene blue and indigo carmine by mungo and tapilan nodule bacteria in soil extract glucose solution*

ISOLATE	INDIGO CARMINE		METHYLENE BLUE	
	1:50,000	1:250,000	1:50,000	1:250,000
Mungo:				
1	+	+	—	+
2	+	+	+	+
5	+	+	—	+
CN 1	—	+	—	+
CN 2	+	+	+	+
CN 3	+	+	—	+
CN 4	+	+	+	+
Tapilan:				
T11	+	+	+	+
T12	+	+	—	+
T31	+	+	+	+
T51	+	+	—	—
T52	+	+	—	+

+ Reduced; — not reduced.

old culture of an isolate. The flasks were plugged with cotton, wrapped with wax paper, and incubated for six weeks at 28°C. After six weeks, the gum produced was precipitated and reprecipitated with acetone (Fred, 1911) and dried to constant weight at 80°C.

TABLE 5.—*Gum production on Buchanan's peptone sucrose medium per 100 ml. of culture*

ISOLATE	DRY WEIGHT OF GUM IN MG.
Mungo:	
1	115.1
2	102.5
5	86.3
CN 1	41.0
CN 2	78.8
CN 3	54.6
CN 4	63.2
Tapilan.	
T11	59.5
T12	39.5
T31	75.1
T51	58.3
T52	72.8

TABLE 6.—*Growth of mungo and tapilan nodule bacteria at different pH on Bryan's medium*

pH	MUNGO ISOLATES							TAPILAN ISOLATES				
	1	2	5	CN 1	CN 2	CN 3	CN 4	T11	T12	T31	T51	T52
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	+	+	—	—	—	—	—	—	+	+	—
5	++	++	++	++	++	+	+	+	+	++	++	+
6	+++	++	++	+++	+++	++	++	++	++	+++	++	+
7	+++	+++	+++	+++	+++	+++	++	+++	+++	+++	+++	++
8	+++	+++	+++	+++	+++	+++	+++	+++	+++	+++	++	+++
9	++	++	+++	+++	++	++	++	++	++	+++	++	++
10	+	+	++	++	+	+	+	++	+	++	++	+

— No growth; + slight growth; ++ moderate growth; +++ excellent growth.

Tapilan isolate T31, which tolerated the highest concentration of crystal violet, produced the greatest amount of gum (table 5). This finding conforms with the report of Fred, Whiting, and Hastings (1926) that the cultures of nodule bacteria which can withstand the highest concentration of crystal violet are heavy slime producers. However, this did not hold true for tapilan isolate T11 although it produced a moderate amount of gum.

A considerable amount of gum, from 41 mg. to 115 mg., was produced by the mungo isolates. Isolate 1 produced the greatest amount of slime and was the only isolate that withstood the 1:20,000 concentration of crystal violet.

Growth of the isolates at different pH levels. The importance of soil reaction on nodule bacteria, especially when they are introduced in the soil, is well recognized. Fred and Loomis (1917) reported that an alkaline reaction is more favorable to the growth of bacteria than an acid reaction. Since soil solutions have a wide range of reaction, varying from pH 3.0 to 9.0, it was decided to determine the critical hydrogen-ion concentration of the isolates of mungo and tapilan nodule bacteria in pure cultures and the extent of growth of the isolates at different pH levels.

Bryan's medium was used with adjusted pH of 3.0 to 10.0 at intervals of one unit. Each culture was inoculated with a loopful of bacterial suspension. Triplicate tubes were maintained for each pH. The cultures were incubated at 28°C. and observed daily for two weeks.

The critical reaction for the mungo and tapilan nodule bacteria was a pH of 4.0 (table 6). Below this pH, no growth was observed in all the isolates. The most favorable trend of reaction was toward the alkaline. The optimum reaction for growth of the bacteria ranged from pH 6.0 to 9.0.

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Glory be to God for dappled things—
For skies of couple-color as a brindled cow;
For rose-moles all in stipple upon trout that swim;
Fresh-firecoal chestnut-falls; finches wings;
Landscape plotted and pieced-fold, fallow and plough;
And all trades, their gear and tackle and trim.

—Gerard Manley Hopkins

RELATION OF NITROGEN TO CALCIUM IN THE CULTURE SOLUTION [1]

J. R. Velasco and S. N. Fertig [2]

WITH TWO TEXT FIGURES

Addition of calcium as calcium chloride to a solution high in nitrogen increased growth of rice seedlings. The development of roots was proportionate to the increase in calcium; that of tops was proportionate, within limits, to the increase in nitrogen. A nitrogen-to-calcium ratio of about 2 was considered best for optimum development of shoot and root.

A nitrate-to-ammonium ratio of 1.7 was found best for rice. A very high ratio of nitrate caused chlorosis of the young leaves. The solution with a high ratio of ammonium produced dark green plants which did not weigh much.

In a study on nutrient absorption by young rice plants, Velasco *et al.* noted that nitrogen and potassium were absorbed at a very rapid rate in spite of their relatively small amounts in Espino's 4-salt solution.[3] On the other hand, the calcium, magnesium, and phosphate ions were absorbed slowly. The writers accordingly modified the solution so that the proportion of ions would reflect the trend of ion absorption. The modified solutions produced luxuriant plants whose roots tended to be shorter and plumper than those of the plants in Espino's 4-salt solution. When some of the plants were grown to more than 45 days, the older roots disintegrated and were replaced by many stubby roots. The condition became progressively worse so that at the end of the experiment the root system was short and stubby, having the appearance of a bottle brush.

After some thought on the matter, it was decided to explore the relationship of nitrogen and calcium in the culture solution. This paper is the report of that study.

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[1] Central Experiment Station Contribution No. 1879. Continuation of Research Project No. 443.

[2] The writers acknowledge the technical assistance of Misses Teofila E. Cabrera and Lucila Espiritu.

[3] J. R. Velasco, T. E. Cabrera, M. R. Vega, and F. T. Ramos, *Philippine Agriculturist*, 39, 96 (1955).

EXPERIMENT 1: EFFECTS OF INCREASING CALCIUM ON GROWTH OF RICE SEEDLINGS

The stubby roots of the rice plants in the preliminary experiment with the modified solutions pointed strongly to a lack of calcium. Espino's 4-salt solution had 0.75 milliequivalent of calcium per liter and the modified solutions had 0.72, or practically the same amount; yet the former produced normal plants, and the latter produced plants that were apparently calcium deficient.

The modified solutions had almost twice as much nitrogen as Espino's 4-salt solution, and this factor might have been responsible for the differences observed. It is conceivable that an increased need for calcium in the solution comes with a greater supply of nitrogen. If calcium absorption is competitively inhibited by nitrogen, then there should be more calcium in the solution to counteract the inhibitory effects of excessive nitrogen. Or if calcium is needed for the proper functioning of the protoplasm, then the high amount of nitrogen, and incidentally, of protoplasm, would demand more calcium from the medium.

The writers thought it pertinent to find out the effects of increased amounts of calcium on culture solution II-B, which had a very high nitrogen content both in the form of nitrate and ammonium ions.

Materials and methods. Seeds of Elon-elon rice were soaked in water on July 7, 1955, and laid out, after 24 hours, on 1-millimeter meshed cloth over a pan of water. The seedlings were transferred to the different culture solutions when they were nine days old. The method of culture was the same as that described by Hsieh.[4]

The culture solutions were the following:

SALT	I	II-A	II-B	II-C	II-D	II-E
			concentration, 10^{-4} molar			
$Ca(NO_3)_2$	3.75	3.6	3.6	5.4	3.6	3.6
KNO_3	—	3.6	7.2	5.4	7.2	7.2
$(NH_4)_2SO_4$	3.75	5.4	7.2	7.2	7.2	7.2
$MgSO_4$	10.00	5.4	3.6	1.8	3.6	3.6
KH_2PO_4	2.50	1.8	1.8	3.6	1.8	1.8
$CaCl_2$	—	—	—	—	3.6	7.2

Culture I was Espino's 4-salt solution; cultures II-A and II-B were modified solutions based on the rates of ion absorption from

[4] Feng Yuan Hsieh, *Philippine Agriculturist*, 30, 251 (1941).

Espino's 4-salt solution; and cultures II-C, II-D, and II-E were essentially culture II-B with increased amounts of calcium.

All the cultures received a mixture of the minor elements boron, copper, manganese, molybdenum, and zinc, as prescribed by Arnon.[5] They were also given 1.26 ppm. of iron as ferric chloride every other day. The cultures in all the subsquent experiments were likewise given the minor elements and iron.

Results and discussion. During the first 20 days of the experiment, there was hardly any difference among the cultures, but on about the 24th day, slight differences were noticeable. Culture II-D was most vigorous, possessing dark green leaves and long, white roots.

Cultures II-A and II-B had the longest root systems up to the 14th day, but thereafter they were surpassed by cultures II-C and II-D.

At the end of the experiment, cultures II-B and II-E had the most tillers (table 1). Culture II-D, however, had the highest weight of fresh tops, followed by culture II-E. Apparently, the increased calcium had a salutary effect on the tops as well as on the roots. It may be noted that in spite of its long roots, culture I had about the lightest root system, 2.46 grams fresh weight. Differences, however, were not significant.

With the top-to-root ratio of 1.6 in culture I as the standard of comparison, all the cultures in the modified solutions tended to be top heavy. The most undesirable ones were cultures II-B and II-C, which developed almost three times as much tops as roots.

Based on all the criteria, culture II-D apparently deserves further trial.

EXPERIMENT 2: EFFECTS ON GROWTH OF VARIOUS RATIOS OF NITROGEN AND CALCIUM

Early in the first experiment it was realized that the addition of calcium chloride to culture II-B could not go on indefinitely as the total molarity would progressively increase and the solutions would not then be strictly comparable. To obviate the use of solutions which vary in molarity, the nitrogen-containing salts were diminished as calcium chloride was increased.

[5] D. I. Arnon, *Amer. Jour. Bot.*, 25, 322 (1938).

TABLE 1.—*Harvest data on 44-day-old rice plants grown in solutions with varying amounts of calcium* [a]

CRITERION	I	II-A	II-B	II-C	II-D	II-E	SMD 5%
Height of tops, cm.	54.2	54.5	69.5	67.5	71.0	69.9	
Length of roots, cm.	22.6	18.0	19.0	20.2	17.7	19.0	
Number of tillers	3.3	2.3	4.0	3.9	3.9	4.0	
Fresh weight of tops, grams	4.32	6.42	8.02	6.39	8.90	8.46	2.02
Fresh weight of roots, grams	2.46	3.10	2.96	2.35	4.08	3.98	Insignificant
Dry weight of tops, grams	0.84	1.02	1.31	0.99	1.38	1.36	0.38
Dry weight of roots, grams	0.30	0.31	0.33	0.26	0.42	0.40	0.06
Top-to-root ratio of fresh weight	1.6	2.1	2.7	2.7	2.2	2.1	

[a] Average of 10 observations.

TABLE 2.—*Harvest data on 40-day-old rice plants grown in solutions with varying nitrogen-to-calcium ratios* [a]

CRITERION	II-F	II-G	II-H	II-I	II-J	II-K	SMD 5%
Height of tops, cm.	67.9	67.9	69.4	67.9	66.4	61.4	
Length of roots, cm.	16.1	17.8	20.0	21.3	27.7	33.2	
Number of tillers	4.0	3.9	5.1	4.0	4.1	3.6	
Fresh weight of tops, grams	7.46	7.21	7.92	6.48	6.56	6.03	I
Fresh weight of roots, grams	2.30	2.76	3.12	3.10	3.14	3.59	0.83
Dry weight of tops, grams	1.09	1.24	1.37	1.13	1.16	1.09	I
Dry weight of roots, grams	0.24	0.29	0.38	0.29	0.37	0.41	0.09
Top-to-root ratio of fresh weight	3.2	2.6	2.5	2.1	2.1	1.7	

[a] Average of 10 observations.

Materials and methods. Seeds were soaked on August 15, 1955, and allowed to germinate under the same conditions obtaining in experiment 1. The seedlings were transferred to the following culture solutions when they were seven days old:

SALT	II-F	II-G	II-H	II-I	II-J	II-K
			concentration, 10^{-4} molar			
$Ca(NO_3)_2$	3.1	2.7	2.5	2.1	1.8	1.5
KNO_3	6.2	5.6	5.0	4.3	3.7	3.1
$(NH_4)_2SO_4$	6.2	5.6	5.0	4.3	3.7	3.1
$MgSO_4$	3.1	3.1	3.1	3.1	3.1	3.1
KH_2PO_4	1.5	1.5	1.5	1.5	1.5	1.5
$CaCl_2$	—	—	—	—	—	—
N:Ca	4.0	2.6	1.8	1.3	0.9	0.7

Culture II-F was similar to culture II-B in the previous experiment except that the molarity was brought down from 0.00234 to 0.002. But for the molarity, culture II-H was similar to culture II-D, which was the best in the first experiment. With the decrease in nitrogen and the increase in calcium, the nitrogen-to-calcium ratio dropped from 4.0 in culture II-F to 0.7 in culture II-K.

The nitrogen-to-calcium ratio was obtained by dividing the total milliequivalents of nitrate and ammonium nitrogen in the solution by the milliequivalents of calcium. For example, culture II-F had $(0.31 \times 2 + 0.62 + 0.62 \times 2)$ or 2.48 milliequivalents of nitrogen, and 0.31×2 or 0.62 milliequivalents of calcium. The nitrogen-to-calcium ratio was 2.48/0.62, or 4.0.

Results and discussion. Differences in appearance of the tops began to show on the 14th day of the experiment. Cultures II-J and II-K tended to be pale green, tall, and lanky; culture II-H was stocky and dark green. Thereafter, culture II-H began to pick up in height and, at the end of the experiment, had surpassed the other cultures (fig. 1).

Also on the 14th day, differences in appearance of the roots became noticeable. Cultures II-J and II-K with very high amounts of calcium had the longest roots until the end of the experiment (fig. 2). It will be noted that the length of roots was directly proportional to the amount of calcium in the solution.

Culture II-H had the highest average weight of tops. Differences in weight of tops between any pair of cultures were not significant. Cultures II-F and II-G had significantly lighter roots than culture II-K which had the heaviest (table 2).

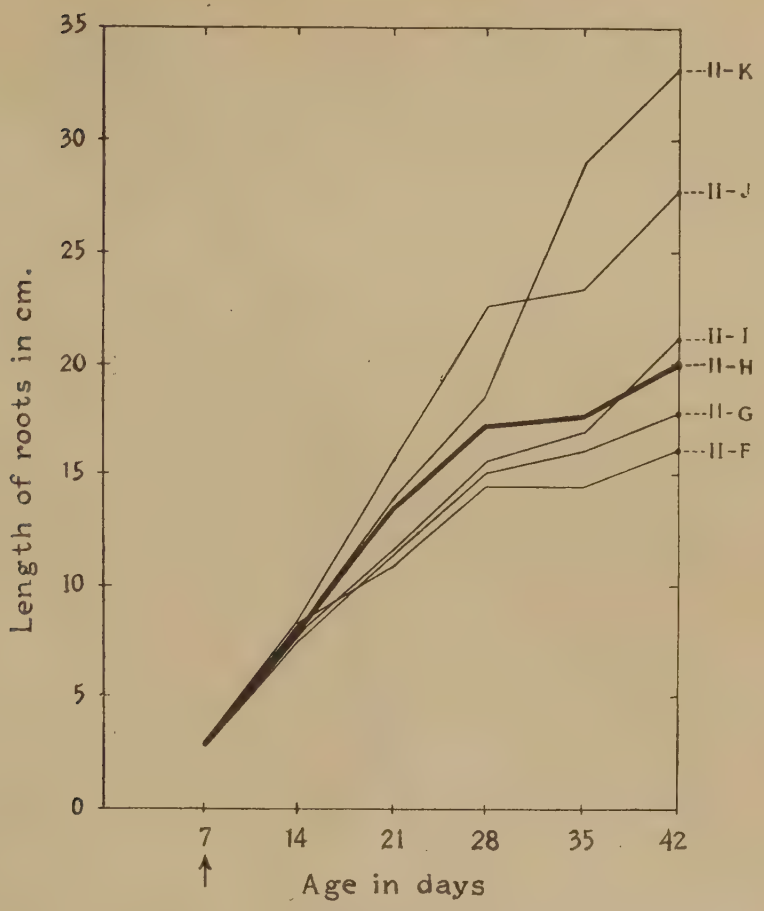

Fig. 1.—Length of tops of rice plants receiving varying ratios of nitrogen and calcium in the culture solutions.

When the shoot and root are considered, culture II-H seems to be the most promising because it produced the highest mean dry weight of tops and the second highest dry weight of roots. The difference between culture II-H and culture II-K, which produced the highest dry weight of roots, was not significant. It will be recalled that culture II-H was almost identical with culture II-D, the best in experiment 1.

A nitrogen-to-calcium ratio of 1.8 (culture II-H), or not exceeding 2, seems to be worth further observation. It will be recalled that Espino's 4-salt solution has a ratio of 2, and Hoagland's solution No. 2 has a ratio of 1.9.

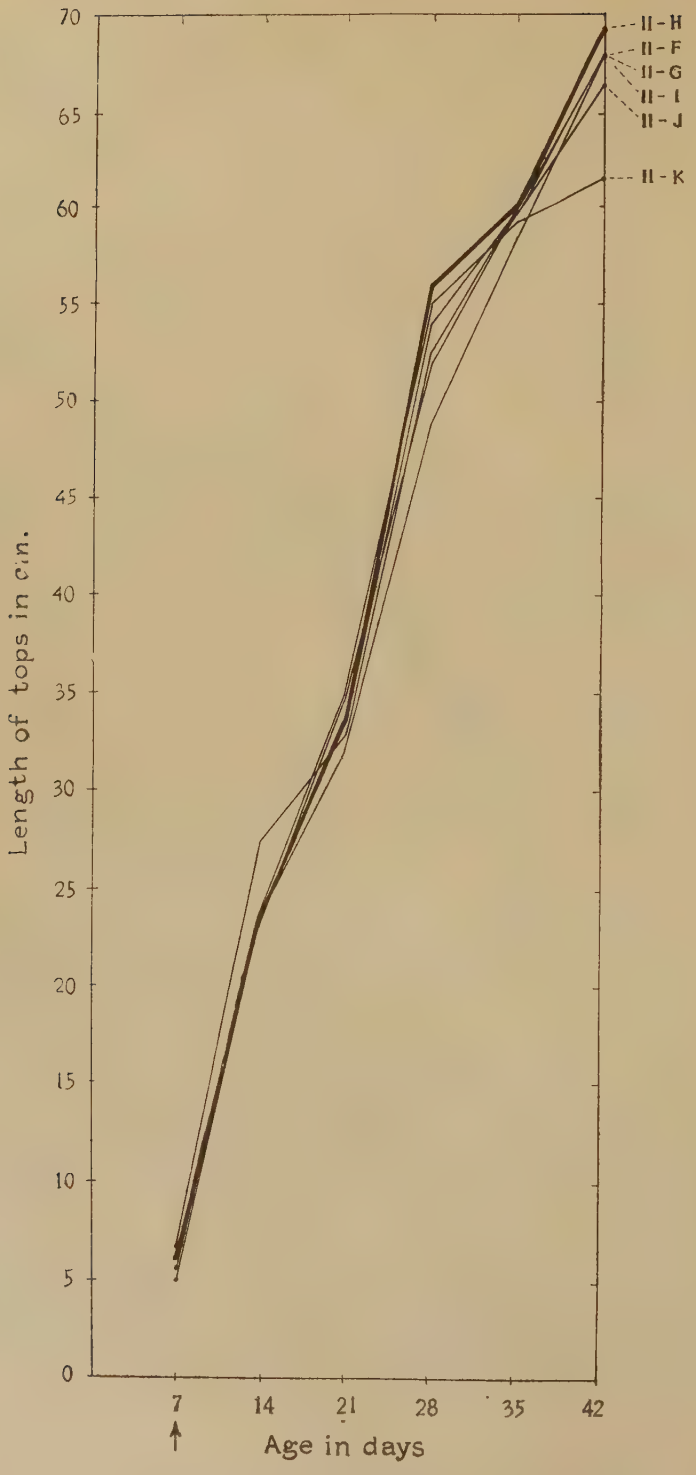

Fig. 2.—Length of roots of rice plants receiving varying ratios of nitrogen and calcium in the culture solutions.

EXPERIMENT 3: EFFECTS OF VARIOUS LEVELS OF NITRATE

Although culture II-H was very desirable, it could still be improved upon. For instance, using calcium chloride as a source of calcium in addition to calcium nitrate resulted in a solution of six salts. While it would have been hard without calcium chloride to establish the optimum nitrogen-to-calcium ratio, a solution consisting of fewer salts but accomplishing the same end would be preferable.

One objection to calcium chloride is its incidental introduction of the chloride ion, which Broyer *et al.* demonstrated to be an essential element [6] but which some of our unpublished data show to be detrimental to rice plants at certain concentrations.

In this experiment, an attempt was made to keep the number of salts down to five or less and the nitrogen-to-calcium ratio at about 2.

Materials and methods. Seeds of Elon-elon were soaked on September 19, 1955. When they were 10 days old, the seedlings were transferred to the following culture solutions:

SALT	I	III	IV	V	VI	VII (II-H)	VIII	IX	X (II-J)
				concentration, 10^{-4} molar					
$Ca(NO_3)_2$	3.75	7.25	7.00	7.00	7.00	2.50	8.00	7.70	1.80
KNO_3	—	3.50	8.00	4.00	6.00	5.00	7.00	7.70	3.70
$(NH_4)_2SO_4$	3.75	3.75	—	4.00	2.00	5.00	—	—	3.70
$MgSO_4$	10.00	3.00	3.00	3.00	3.00	3.10	3.00	3.10	3.10
KH_2PO_4	2.50	2.50	2.00	2.00	—	1.50	—	—	1.50
$NH_4H_2PO_4$	—	—	—	—	2.00	—	2.00	1.50	—
$CaCl_2$	—	—	—	—	—	3.10	—	—	6.10
NO_3:NH_4	1	1.4	22.0	2.25	3.3	1	11.5	15.4	1

The nitrate-to-ammonium ratio varied from 1:1 in cultures I, VII, and X to 22:0 in culture IV. Culture I was Espino's 4-salt solution, culture VII (II-H) was the best solution in experiments 1 and 2, and culture IX was Hoagland's solution diluted to 0.002 molar.

Results and discussion. During the first week of treatment, culture IV with nitrogen entirely in the form of nitrate turned light green. The roots were dull and apparently dying. In the second week, cultures VIII and IX also had chlorotic young leaves although the plants looked healthier than culture IV. Even culture V, which had a fairly good supply of ammonium sulfate, tended to be pale

[6] T. C. Broyer, A. B. Carlton, C. M. Johnson, and P. R. Stout, *Plant Physiol.*, 29, Feb. (1954).

TABLE 3.—*Harvest data on 47-day-old rice plants in solutions with varying nitrate-to-ammonium ratios* [a]

CRITERION	I	III	IV	V	VI	VII (II-H)	VIII	IX	X (II-J)	SMD 5%
Height of tops, cm.	58.4	69.0	42.8	68.8	62.0	64.8	68.3	64.1	60.0	
Length of roots, cm.	14.4	27.0	20.0	29.2	23.5	23.2	24.9	23.9	25.1	
Number of tillers	3.7	4.0	1.2	4.8	3.9	4.2	3.8	2.8	3.6	
Fresh weight of tops, grams	3.59	7.96	1.35	8.07	6.79	7.67	7.04	5.82	6.16	1.61
Fresh weight of roots, grams	1.81	4.18	0.84	4.65	3.62	5.34	3.62	3.40	4.17	1.03
Dry weight of tops, grams	0.58	1.27	0.19	1.51	1.03	1.16	1.07	0.82	1.10	0.23
Dry weight of roots, grams	0.20	0.39	0.12	0.46	0.33	0.46	0.34	0.27	0.47	0.12
Top-to-root ratio of fresh weight	1.98	1.88	1.6	1.73	1.88	1.44	1.94	1.71	1.48	

[a] Average of 10 observations.

green especially when the sky was overcast. The cause could not have been insufficient ammonium ion *per se* because cultures I, III, VII, and X, which had about the same amount of ammonium ion, did not exhibit this chlorotic tendency. Rather, it may be attributed to the ratio between the nitrate and ammonium ions. While culture V had a nitrate-to-ammonium ratio of 2.25, the other cultures had a ratio of 1. For best chlorophyll development, it may not be safe to exceed a ratio of 2.25.

At harvest, cultures III and V were the tallest (table 3). Culture V had the longest roots, the most tillers, and the heaviest tops. Differences in fresh weight of tops between culture V on the one hand and cultures I, IV, IX, or X on the other were significant.

The top-to-root ratio in culture 1 was 1.98; in the previous experiment it was 1.6. This variation may have been due to varying light conditions and temperature. All the cultures produced well-proportioned plants, with top-to-root ratios ranging from 1.44 to 1.98. This may mean that the nitrogen-to-calcium ratio of about 2 that was maintained in all the cultures largely determined the proportion of top and root development.

Culture V may be preferred to culture VII (II-H), which was best in the previous experiments, because it consists of only five salts and produced consistently bigger plants.

A supplementary culture was started on October 30, 1955, to find the effect of an increased supply of ammonium ion. Ammonium sulfate was 4×10^{-4}M in culture V, 6×10^{-4}M in culture XI, and 8×10^{-4}M in culture XII; potassium nitrate was reduced from 4×10^{-4}M to 2×10^{-4}M and 0, respectively. The nitrate-to-ammonium ratio in culture V was 2.25; in culture XI, 1.33; and in culture XII, 0.88.

The harvest data are presented in table 4. Although the plants in culture XI and XII tended to be darker green, the plants in culture V were heavier and more vigorous.

On December 19, 1955, another experiment was started to find a better solution than that of culture V because the change in nitrate-to-ammonium ratio in cultures XI and XII was felt to be quite abrupt. The following culture solutions were tried:

SALT	I	V	XVI	XVII
		concentration, 10^{-4} molar		
$Ca(NO_3)_2$	3.75	7.0	7.0	7.0
KNO_3	—	4.0	3.5	3.0
$(NH_4)_2SO_4$	3.75	4.0	4.5	5.0
$MgSO_4$	10.00	3.0	3.0	3.0
KH_2PO_4	2.50	2.0	2.0	2.0
NO_3:NH_4	1	2.25	1.94	1.70

Cultures XIII, XIV, and XV were not included because they had to do with the relation of nitrogen to potassium.

TABLE 4.—*Harvest data on 49-day-old rice plants in solutions with varying nitrate-to-ammonium ratios* [a]

CRITERION	V	XI	XII	SMD 5%
Height of tops, cm.	59.20	51.16	52.63	
Length of roots, cm.	25.51	20.93	17.96	
Number of tillers	4.1	3.9	3.9	
Fresh weight of tops, grams	5.804	4.945	4.284	0.52
Fresh weight of roots, grams	4.086	3.155	2.056	0.40
Dry weight of tops, grams	1.002	0.835	0.859	0.011
Dry weight of roots, grams	0.366	0.266	0.208	0.048
Top-to-root ratio	1.43	1.57	2.09	

[a] Average of 10 observations.

During the first three weeks, the cultures did not differ very much from each other. Culture XVII was dark green and seemed most promising, but not distinctly more promising than cultures V and XVI. On the fourth week, culture I became distinctly paler green than the others. On the fifth week, irregular white streaks developed on the young, apparently deformed leaves.

The harvest data on the 49-day-old plants show that although culture XVII was the best, it did not differ significantly from cultures V and XVI (table 5). Since culture XVII had a slight advantage over the other two on most counts, it will be used in subsequent studies and will be designated as rice solution 17 or RS-17.

GENERAL DISCUSSION

The data show that when the ratio of nitrogen to calcium in the medium greatly exceeds 2, the plant tends to produce a heavy top and a stubby root system. When the ratio is in the neighborhood of 2, the plant develops from 1.5 to 2 times as much top as roots.

There were indications that better development of roots because of increased calcium in turn promoted better growth of top. Burstrom mentioned calcium and boron to be of special value in root growth.[7] Maximal rate of cell multiplication of wheat roots at an optimal pH of 5 to 6 is obtained with a calcium concentration as low as 10^{-6} molar or 0.04 ppm. in the nutrient solution. A rise in the calcium concentration up to 10^{-4} molar at a pH above 5, however, increases cell elongation. It is concluded that calcium, besides being nutritious at low concentrations, acts as a genuine cell elongation factor in some kind of interaction with auxin.

TABLE 5.—*Harvest data on 49-day-old rice plants in solutions with varying nitrate-to-ammonium ratios* [a]

CRITERION	I	V	XVI	XVII	SMD 5%
Height of tops, cm.	50.3	57.0	58.6	59.6	
Length of roots, cm.	23.4	29.2	28.4	27.1	
Number of tillers	3.9	4.8	5.2	5.5	
Fresh weight of tops, grams	6.32	9.63	9.54	10.05	1.26
Fresh weight of roots, grams	4.81	6.86	6.25	6.81	1.03
Dry weight of tops, grams	1.36	1.87	1.86	1.91	0.26
Dry weight of roots, grams	0.61	0.74	0.70	0.72	Insig.
Top-to-root ratio of fresh weights	1.31	1.40	1.53	1.48	

[a] Average of 10 observations.

The calcium concentration in culture II-B was 3.6×10^{-4} molar, and the initial pH of the solution was 5.12. This was sufficient to supply the calcium requirement for cell multiplication and cell elongation. The rice plants, however, still produced roots that soon disintegrated and were replaced by progressively shorter roots. It would seem that the role of calcium in the vital activity of the protoplasm needs to be explored.

In the field the common assumption is that liming is for the sole purpose of correcting the soil reaction. Hence, the pH of the soil is determined to see whether or not the soil needs liming, and how much. The present experiments and those of Burstrom demonstrate that there are important functions of calcium other than correcting the soil reaction.

It is not infrequent that applications of ammonium sulfate produce dark green, luxuriant plants which later lodge and produce little or no grains. Nitrogen probably exceeds the amount that is

[7] H. Burstrom, *Ann. Rev. Plant Physiol.*, 4, 237 (1953).

ideal for the available calcium in the soil so that the development of the roots is not proportionate to the heavy production of tops. Worse, the healthy roots produced during the early stage of growth soon disintegrate and are replaced by progressively shorter roots. This is very undesirable because (1) the plant is poorly anchored and may lodge with the slightest breeze and (2) the feeding zone is limited to that portion of the soil depleted by the older roots which have disintegrated. Hence, the plant that reaches bearing age is isolated, as it were, from its source of nutrient and subsists merely on whatever reserve it has accumulated.

Wherever there is the slightest possibility of the human mind *to know*, there is a legitimate problem of science.

—*Karl Pearson*

CANE MOLASSES IN POULTRY RATIONS: I. THE INFLUENCE OF CANE MOLASSES IN RATIONS FOR YEARLING HENS[1]

ALBERTO B. DALANGIN and F. M. FRONDA

WITH ONE TEXT FIGURE

Layers fed rations in which 10 and 20 parts of molasses replaced 5 and 10 parts, respectively, of ground corn laid practically the same number of eggs as those given the standard laying ration. The birds fed the full corn ration required the least amount of feed to produce a dozen eggs, but those fed cane molasses required about the same cost to produce the same number of eggs. Mortality was lower among the birds fed molasses. Cane molasses did not increase the weight of the birds.

A certain amount of cane molasses is now utilized in the manufacture of alcohol, and a small portion is used in feeding horses and swine. A very small amount is used as an ingredient in locally mixed feeds for poultry. Being a cheap by-product, cane molasses may considerably lower the cost of feeding if more of it is used in poultry rations.

A considerable number of studies have been conducted on feeding cane molasses to growing chicks, pullets, and laying hens (Ewing, 1951; Scott, 1953; Wuth and Rosenberg, 1954; Rosenberg, 1954, 1955; Winter, 1929; Maw, 1933; Norris and Heuser, 1935; Bice, 1933; Upp, 1937; Ott *et al.*, 1942). To determine its influence on egg production of yearling hens under local conditions, this study was conducted in the Department of Animal Husbandry from January 16, 1955, to November 15, 1955.

MATERIALS AND METHODS

Ninety Single Comb White Leghorn yearling hens of the College flock were distributed at random into three lots of 30 layers each. All the birds in the three lots had free access to all-mash laying rations made up of the following ingredients, all parts by weight:

[1] Central Experiment Station Contribution No. 1880. Progress report of Research Project No. 693.

	LOT I	LOT II	LOT III
Ground yellow corn	50	45	40
Fine rice bran	20	20	20
Copra meal	10	10	10
Fish meal	20	20	20
Cane molasses	—	10	20
Salt	1	1	1

For every part of ground corn removed from the rations given to lots II and III, two parts of cane molasses was substituted.

The same care and management was given to the birds in all the three lots. There was no culling throughout the study. Records were kept of the initial and final weights of the birds, amount of feed consumed, mortality, and daily egg production of each lot.

RESULTS AND DISCUSSION

Body weight. At the start of the study, the birds in lot I weighed more than those in lots II and II (table 1). At the close of the study, the birds in the three lots had slightly decreased in weight. The birds in lots I and III had practically the same average final weight, which was higher than that of lot II. All of them were in good condition at the end of the observation period.

TABLE 1.—*Influence of cane molasses in the rations of S. C. White Leghorn yearling hens*

ITEM	LOT I	LOT II	LOT III
Average weight at the start, kilograms	1.61	1.54	1.53
Average weight at close, kilograms	1.47	1.41	1.48
Number of eggs produced	2,566	2,894	2,534
Egg production of a bird, number [a]	112.1	106.0	102.2
Egg production of a bird, per cent [b]	36.9	34.9	33.6
Feed consumed by a bird, kilograms [a]	26.7	26.3	27.9
Feed needed to produce a dozen eggs, kilograms	2.86	2.98	3.27
Cost of feed to produce a dozen eggs, pesos	0.64	0.65	0.67
Mortality, per cent	43.33	23.33	33.33

[a] Ten months.

[b] $\frac{\text{Egg production per bird}}{303} \times 100.$

Mortality. Deaths in the three lots were mostly due to leukosis complex. Lot I had 43.33 per cent mortality; lot II had the lowest, 23.33 per cent (table 1). These results corroborate the reports of Winter (1929) and Maw (1933) that mortality was less among birds fed molasses.

Egg production. During the 10-month period, the birds in lot II produced 328 more eggs than lot I and 360 more than lot III (table 1). It may be noted that the egg production curves of all the lots followed the same pattern, except on the last month of the experiment (fig. 1). The hens in lot I produced only 2.0 per cent more eggs than lot II and 3.3 per cent more than lot III. The birds in lot I produced 112.1 eggs (36.9 per cent of the maximum potential); in lot II, 106.0 eggs (34.9 per cent); and in lot III, 102.2 eggs (33.6 per cent). Differences were not significant, corroborating the findings of Winter (1929) and Maw (1933).

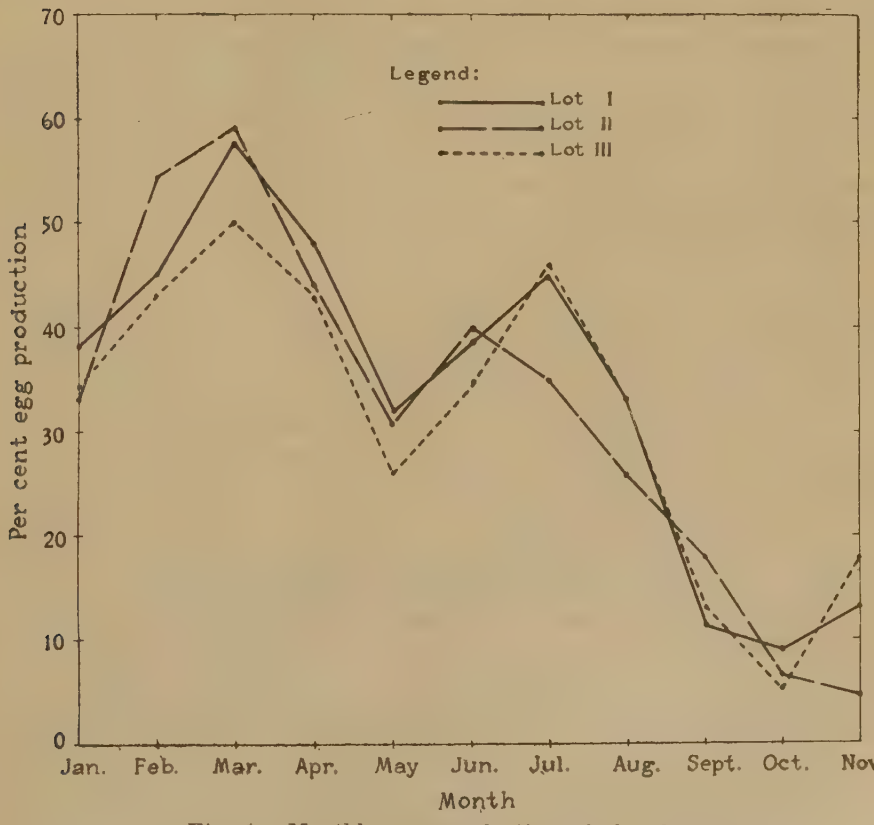

Fig. 1.—Monthly egg production of the three lots.

Amount and cost of feed consumed. Molasses in the ration apparently did not increase feed consumption appreciably (table 1). Lot I was the most efficient in feed utilization, and lot III, the least.

The cost of feed consumed to produce a dozen eggs was about the same in the three lots, however.

Returns above cost. The returns above cost of feed for lot I were ₱115.75; for lot II, ₱131.48; and for lot III, ₱108.29. If the cost of feed to produce eggs comprises 60 per cent of the total cost of production (Fronda and Paje, 1930), lot I needed an over-all expense of ₱1.07 to produce a dozen eggs; lot II, ₱1.08; and lot III, ₱1.12. At ₱0.10 an egg, the corresponding net returns for lot I were ₱27.80 for all eggs produced; for lot II, ₱28.94; and for lot III, ₱16.89. These figures show that the highest net returns were realized from lot II, which was given the ration in which 5 parts ground corn was replaced with 10 parts cane molasses.

Minor observations. The droppings of the birds fed cane molasses were very watery, corroborating the findings of Bice (1933) and Norris and Heuser (1935). The litter of these birds was moist and darker brown than the litter of the birds fed the ration without molasses. It was also observed that the feathers of the birds given the ration with cane molasses were dirty.

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ELIMINATION OF PUPILS IN THE CENTRAL AND BARRIO SCHOOLS OF LOS BAÑOS, LAGUNA [1]

GIL F. SAGUIGUIT, BEATRIZ A. DE CASTRO, and MODERNO R. ALBALADEJO

Of the 882 first-grade pupils in 1946 and 1947, only 377, or 43 per cent, were able to finish the elementary grades. A large number left school during or after completion of the fourth and fifth grades. Financial difficulty was the main reason for leaving school. Most popular occupational interests among the in- and out-of-school boys were farming, fishing, military service, and poultry raising; among the girls, dressmaking, teaching, poultry raising, and nursing.

The high percentage of elimination in the elementary grades and the narrow range of occupational interests point to the need for more adequate elementary school facilities and an educational program that will be profitable to the youth who leave school at an early age.

A deplorable feature of the Philippine educational system is the amazingly high rate of elimination in the elementary level of instruction. Isidro [2] estimated that out of 100 pupils who enter the first grade, only six reach the first year of high school. This means a rate of elimination of 94 per cent before the pupils reach the secondary level of education. In recent studies conducted by Sapaden,[3] Avila,[4] and Gabertan [5] in various parts of the Philippines, the rate of elimination found in elementary schools was about 53 per cent.

There is a need in the Philippines for more studies on the elimination of pupils enrolled in the public elementary schools. The data

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[1] Central Experiment Station Contribution No. 1881. Based on the theses presented by the junior authors for graduation with the degree of Bachelor of Science in Agriculture. Prepared in the Department of Agricultural Education under the direction of the senior author.

[2] A. Isidro, "Principles of Education Applied to the Philippines," 1950, 435 pp. (Mimeographed).

[3] F. Sapaden, "A Study of the Elimination of Pupils in the Central and Barrio Schools of Bangui, Ilocos Norte." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1954. Unpublished.)

[4] D. Avila, "A Study of the Elimination of Pupils in the Central and Barrio Schools of Tanauan, Leyte." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished.)

[5] L. Gabertan, "A Study of the Elimination of Pupils in the Central and Barrio Schools of Bay, Laguna." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1955. Unpublished.)

obtained can guide the formulation of wise policies and measures to remedy shortcomings of the educational system and offset the adverse effects of a high rate of elimination. The present study was undertaken to help satisfy the need. Specifically, its objects were to determine (a) the extent of elimination in the central and barrio schools of Los Baños, Laguna; (b) the extent of schooling of the pupils who dropped out; (c) the reasons for leaving school; and (d) the occupational interests of in-school and out-of-school children of elementary school age.

MATERIALS AND METHODS

This study included 882 pupils enrolled in the first grade in 1946 and 1947 in one central and three barrio schools of Los Baños, Laguna. These pupils were all residents of Los Baños, except a few who lived in the adjoining towns of Bay and Calamba.

Data were obtained from school records and from personal interviews with the aid of an appropriate questionnaire. Although the investigation lasted from November, 1952, to October, 1955, most of the work was done in April and May of 1953 and 1954.

RESULTS AND DISCUSSION

Description of the area surveyed. The population of the municipality of Los Baños in 1950 was 10,044, distributed as follows: Poblacion, 1,806; Mayondon, 1,920; Bayog, 958; San Antonio, 964; Maahas, 365; Batong Malake, 1,734; Bambang, 923; Lalakay, 167; Anos, 1,077; and Tadlak, 130.

The poblacion of Los Baños is along the provincial and national highways and, together with some barrios, borders Laguna de Bay. The other barrios are traversed by the provincial road or are connected to it by macadamized and dirt roads. There are two railroad stations in the municipality: one in the poblacion and another in Junction, a district of Mayondon.

Fishing, farming, and duck raising are the principal occupations in the barrios bordering Laguna de Bay. A large portion of the population of the poblacion and the barrios of Lalakay, San Antonio, Maahas, and Batong Malake is employed by the Colleges of Agriculture and Forestry, the Economic Garden of the Bureau of Plant Industry, the two railroad stations, a division of the Bureau of Forestry, the stone quarry of the Bureau of Public Highways, and some private recreational establishments.

The central school in the poblacion and the barrio schools in Mayondon and San Antonio offer complete elementary instruction. The school in Bayog offers instruction up to the fourth grade.

Sex of pupils and age at enrollment. The ratio of boys to girls was almost 1:1. The ages at enrollment ranged from 5 to 15 years, or an average of 8 years (table 1). More than 70 per cent of the pupils were between 7 and 9 years of age.

TABLE 1.—*Sex of pupils and age at enrollment*

AGE	BOYS	GIRLS	TOTAL	PER CENT
5	1	2	3	[a]
6	12	21	33	4
7	99	116	215	24
8	148	147	295	33
9	82	68	150	17
10	57	56	113	13
11	25	15	40	4
12	12	3	15	2
13	5	6	11	1
14	3	0	3	[a]
15	3	1	4	[a]
Total	447	435	882	100
Average	8	8	8	

[a] Less than 1 per cent.

Districts from which pupils were drawn. A large proportion of the pupils came from the barrios. The percentage from the poblacion was only 15 (table 2). About 61 per cent were born in the barrios where they were residing; 14 per cent, in other barrios; and 12 per cent, in the poblacion. Only a few were born outside the municipality of Los Baños.

Occupation of parents or guardians. There were 38 occupational groups to which the parents or guardians of the pupils belonged (table 3). Fishermen (21 per cent) and farmers (17 per cent) were the first and second biggest groups, respectively. About 12 per cent were laborers in various government and private entities in the municipality. The other important occupational groups were duck raisers, employees, merchants, and carpenters. Twenty-five parents and guardians were unemployed.

Persistence of pupils in school. From the first grade to the fourth grade, the rate of elimination was low, but after the fourth

TABLE 2.—*Districts from which pupils were drawn*

DISTRICT	BOYS	GIRLS	TOTAL	
			Number	Per cent
Mayondon	80	73	153	17
Poblacion	81	53	134	15
Bayog	48	68	116	13
Anos	55	38	93	10
Batong Malake	42	24	66	7
San Antonio	21	39	60	7
Bambang	42	29	71	8
Junction	10	32	42	5
Tadlac	13	14	27	3
Maahas	8	17	25	3
Tungtungin	11	4	15	2
College	12	8	20	2
Putho	6	3	9	1
Maitim, Bay	5	3	8	[a]
Lalakay	7	11	18	2
Forestry	2	6	8	[a]
Kapatagan	1	2	3	[a]
Masili, Calamba	2	6	8	[a]
Sucol, Calamba	1	5	6	[a]
Total	447	435	882	100

[a] Less than 1 per cent.

grade it was very high (table 4). About 48 per cent reached the sixth grade, and only 43 per cent finally completed the elementary course.

Although a slightly higher proportion of boys reached the upper grades, the percentage of graduation was the same for both sexes.

Age at graduation. The pupils finished the sixth grade at an average of 14 years (table 5). There were more pupils who graduated at a younger age. Apparently, more of the pupils who were less than eight years old at enrollment were able to graduate.

Highest grade completed by pupils who dropped out. Of the 882 pupils who started out, 505 left school before finishing the sixth grade (table 6). Most of them left during or after completion of the fourth and fifth grades. The average grade completed by both sexes was the fourth grade.

Reasons for leaving school. Financial difficulty was the main reason for leaving school (table 7). Other common reasons given

TABLE 3.—*Occupation of parents or guardians of pupils*

OCCUPATIONAL GROUP	PARENTS	GUARDIANS	TOTAL	PER CENT
Fishermen	167	19	186	21
Farmers	121	27	148	17
Laborers	99	10	109	12
Duck raisers	49	6	55	6
Employees	45	6	51	6
Merchants	38	3	41	5
Carpenters	33	2	35	4
Vendors	24	9	33	4
Pensioners	19	4	23	3
Tailors and dressmakers	13	1	14	2
Laundrywomen	14	2	16	2
Security guards	13	2	15	2
Drivers	13	2	15	2
Agents	13	0	13	1
Clerks	9	1	10	1
Storekeepers	9	2	11	1
Mechanics	11	0	11	1
Street sweepers	8	0	8	[a]
Barbers	7	0	7	[a]
Electricians	6	1	7	[a]
Rig drivers	5	0	5	[a]
Policemen	4	0	4	[a]
Coconut harvesters	3	1	4	[a]
Shoemakers	1	3	4	[a]
Teachers	3	0	3	[a]
Midwives	3	0	3	[a]
Ropemakers	2	1	3	[a]
Blacksmiths	3	0	3	[a]
Postmasters	2	0	2	[a]
Soldiers	4	1	5	[a]
Photographers	2	0	2	[a]
Doctor	1	0	1	[a]
Superintendents	2	0	2	[a]
Bakers	3	0	3	[a]
Radio operators	2	0	2	[a]
Gambler	1	0	1	[a]
Painter	1	0	1	[a]
Mayor	1	0	1	[a]
Unemployed	21	4	25	3
Total	775	107	882	100

[a] Less than 1 per cent.

TABLE 4.—*Persistence of pupils in school*

HIGHEST GRADE REACHED	BOYS		GIRLS		TOTAL	
	Number	Per cent	Number	Per cent	Number	Per cent
I	447	100	435	100	882	100
II	429	96	423	97	852	97
III	423	95	406	93	829	94
IV	396	89	372	85	768	87
V	337	75	300	69	637	72
VI	220	49	203	46	423	48
Graduated	191	43	186	43	377	43

TABLE 5.—*Age at graduation of pupils*

AGE	BOYS	GIRLS	TOTAL	PER CENT
11	1	3	4	1
12	14	28	42	11
13	50	43	93	25
14	80	64	144	38
15	29	36	65	17
16	9	8	17	4
17	5	5	10	3
18	0	2	2	[a]
Total	188	189	377	100
Average	14	14	14	

[a] Less than 1 per cent.

TABLE 6.—*Highest grade completed by pupils who dropped out*

GRADE	BOYS	GIRLS	TOTAL	PER CENT
0	6	1	7	1
I	12	11	23	5
II	6	17	23	5
III	27	34	61	12
IV	59	72	131	26
V	117	97	214	42
VI	29	17	46	9
Total	256	249	505	100
Average	4	4	4	

were parents' need of help, failing health, laziness, overageness, poor mentality, indifference of parents, and sickness of parents.

Sapaden,[6] Avila,[7] and Gabertan [8] reported that the primary reasons for dropping out were financial difficulty, need for services at home, poor scholarship, distance from school, and poor health. In the United States, Monroe reported that poor attendance because of work at home and on the farm was one of the more important causes of elimination of school children.[9]

TABLE 7.—*Reasons for leaving school*

REASON	BOYS	GIRLS	TOTAL	PER CENT
Financial difficulty	83	83	166	30
Parents' need of help	40	51	91	17
Laziness	34	25	59	11
Overageness	22	20	42	7
Failing health	35	33	68	12
Death of parents	9	5	14	2
Poor mentality	15	7	22	4
Indifference of parents	9	12	21	4
Big size of family	4	6	10	2
Distance from school	3	5	8	1
Parents' sickness	12	8	20	4
Marriage	2	7	9	2
Failure	0	2	2	[a]
Quarrel with teacher	5	0	5	[a]
Accident	5	5	10	2
Total	278	269	547	100

[a] Less than 1 per cent.

Age of pupils upon leaving school. Of the 505 pupils who left school, 102 left at the age of 11 years, 142 at 12 years, and 93 at 13 years (table 8). The average age was 12 years.

Pupils' choice of vocational courses. The vocational courses commonly chosen by the boys out of school were mechanics, duck raising, chicken raising, trade courses, horticulture, and swine raising (table 9). Those in school were inclined to chicken raising, mechanics, trade, horticulture, and duck raising. Among the girls out of

[6] Sapaden, *op. cit.*
[7] Avila, *op. cit.*
[8] Gabertan, *op. cit.*
[9] W. S. Monroe, "Encyclopedia of Educational Research," The MacMillan Co., New York, 1950, 1520 pp.

school dressmaking or tailoring was most preferred. Other courses chosen were duck raising, clerical course, and horticulture. Most of the girls in school also preferred dressmaking or tailoring. Other courses chosen were stenography-typewriting, home economics, trade courses, and duck raising.

TABLE 8.—*Age of pupils upon leaving school*

AGE	BOYS	GIRLS	TOTAL	PER CENT
7	1	4	5	1
8	5	2	7	1
9	15	6	21	4
10	24	21	45	9
11	52	50	102	20
12	73	69	142	28
13	32	61	93	18
14	31	17	48	10
15	11	13	24	5
16	8	5	13	2
17	2	1	3	[a]
18	2	0	2	[a]
Total	256	249	505	100
Average	12	12	12	

[a] Less than 1 per cent.

Occupational choice of pupils. The pupils chose a variety of occupations. It was interesting to note that the boys both in and out of school preferred the same occupations of farming, fishing, military service, duck raising, and poultry raising (table 10). Of the 448 boys, only 28 did not give any occupational preference.

Among the girls in school, a greater percentage preferred teaching, dressmaking or tailoring, nursing, and stenography and typewriting. Among those who left school, the majority chose dressmaking, fish selling, duck raising, poultry raising, beauty culture. Of the 434 girls, only 17 did not profess any occupational choice.

Occupation of out-of-school pupils. Most of the boys were fishermen, farmers, and duck raisers; most of the girls were dressmakers, laundresses, fish vendors, duck raisers, and storekeepers (table 11). Some pupils were not in the occupation they preferred.

TABLE 9.—*Pupils' choice of vocational courses*

VOCATIONAL COURSE	OUT OF SCHOOL		IN SCHOOL		TOTAL	
	Boys	Girls	Boys	Girls	Number	Per cent
Dressmaking or tailoring	3	99	8	82	192	19
Duck raising	34	15	25	15	89	9
Horticulture	14	10	30	9	63	6
Chicken raising	20	4	41	7	72	7
Mechanics	40	0	40	0	80	8
Stenography-typewriting	3	6	16	19	44	4
Trade	17	5	31	15	68	7
Clerical	1	14	1	14	30	3
Home economics	0	9	0	19	28	3
Hair science	0	6	0	5	11	1
Swine raising	14	2	20	2	38	4
Cattle raising	8	0	8	0	16	1
Floriculture	4	10	1	8	23	2
Balut making	11	6	6	3	26	2
Carpentry	7	0	9	0	16	1
Music teaching	0	0	2	8	10	1
Electrical	9	0	6	0	15	1
Fish culture	3	0	5	0	8	[a]
Midwifery	0	3	0	4	7	[a]
Blacksmithing	4	0	1	0	5	[a]
Sweets making	0	3	1	2	6	[a]
Baking	2	5	1	3	11	1
Secretarial	0	1	0	6	7	[a]
Plumbing	4	0	1	0	5	[a]
Bookkeeping	0	0	1	4	5	[a]
Watch repairing	2	0	2	0	4	[a]
Agronomy	1	0	3	0	4	[a]
Shoemaking	3	0	1	0	4	[a]
Accounting	0	0	2	1	3	[a]
Jewelry making	1	0	1	0	2	[a]
Wooden-shoe making	1	0	1	0	2	[a]
Banking	0	0	1	0	1	[a]
Telephone operating	0	0	1	0	1	[a]
Beauty culture	0	7	0	5	12	1
None	43	36	20	22	121	12
Total	249	241	286	253	1,029	100

[a] Less than 1 per cent.

TABLE 10.—*Occupational choice of pupils*

OCCUPATION	OUT OF SCHOOL		IN SCHOOL		TOTAL	
	Boys	Girls	Boys	Girls	Number	Per cent
Dressmaking or tailoring	3	44	3	43	93	10
Farming	33	6	38	5	82	9
Fishing	34	7	23	1	65	7
Business	8	8	8	9	33	4
Teaching	7	8	13	50	78	9
Military service	21	0	25	0	46	5
Fish selling	4	21	1	2	28	3
Duck raising	15	15	18	4	52	6
Poultry raising	13	13	16	8	50	6
Storekeeping	0	8	0	2	10	1
Nursing	0	4	0	18	22	2
Mechanics	8	0	7	0	15	2
Clerking	3	8	7	7	25	3
Music teaching	0	1	2	7	10	1
Flower gardening	2	6	2	3	13	1
Aviation	3	0	10	0	13	1
Laundering	0	5	0	0	5	[a]
Beauty culture	0	14	0	6	20	2
Stenography-typewriting	1	4	3	10	18	2
Medicine	1	0	7	5	13	1
Engineering	1	0	9	1	11	1
Pharmacy	0	2	0	8	10	1
Automobile driving	7	0	3	0	10	1
Secretarial work	3	6	1	10	20	2
Industrial arts	2	7	4	4	17	2
Electrical work	3	0	4	0	7	[a]
Rig driving	3	0	1	0	4	[a]
Office work	0	0	2	0	2	[a]
Forestry	3	0	5	0	8	[a]
Radio singing	0	0	0	1	1	[a]
Ballet dancing	0	0	0	1	1	[a]
Law	2	0	3	1	6	[a]
Commerce	6	10	11	8	35	4
Baking	6	2	2	3	13	1
None	18	12	10	5	45	5
Total	210	211	238	223	882	100

[a] Less than 1 per cent.

TABLE 11.—*Occupation of out-of-school pupils*

OCCUPATION	BOYS	GIRLS	TOTAL	PER CENT
Fishing	30	2	32	8
Farming	21	7	28	7
Duck raising	14	10	24	6
Fish selling	2	11	13	3
Storekeeping	3	10	13	3
Bread selling	6	6	12	3
Laundering	0	12	12	3
Dressmaking	0	18	18	4
Sweets making	1	1	2	[a]
Poultry raising	6	6	12	3
Balut selling	6	3	9	2
Rig driving	5	0	5	1
Janitorial work	2	0	2	[a]
Milk peddling	1	1	2	[a]
Restaurant work	0	1	1	[a]
Coconut harvesting	5	3	8	2
Wooden-shoe making	1	0	1	[a]
Carpentry	3	0	3	[a]
Bus conductor work	3	0	3	[a]
Office work	5	3	8	2
Floriculture	0	3	3	[a]
Olericulture	1	5	6	1
Beauty culture	0	2	2	[a]
None	94	109	203	48
Total	209	213	422	100

[a] Less than 1 per cent.

Annual income from occupation of out-of-school pupils. The average annual income of the 108 boys and 98 girls who were out of school amounted to ₱618.00 (table 12).

The survey shows that a greater portion of the pupils left school during or after finishing grades four and five. They could not be sent any longer to school because financial problems necessitated their help at home. Home industries should be encouraged in the rural areas so that the income of the people will be increased. A curriculum that will benefit pupils who finish only the primary grades should be formulated.

TABLE 12.—*Annual income from occupation of out-of-school pupils*

INCOME	BOYS	GIRLS	TOTAL	PER CENT
pesos				
Below 100	1	1	2	1
100– 199	7	7	14	7
200– 299	12	3	15	7
300– 399	15	14	29	14
400– 499	2	10	12	6
500– 599	7	11	18	9
600– 699	6	6	12	6
700– 799	31	20	51	25
800– 899	10	5	15	7
900– 999	12	18	30	14
1,000–1,999	5	3	8	4
Total	108	98	206	100
Average	₱618	₱618	₱618	

That the physical sciences are more objective and more exact than the sciences of man makes them neither more fundamental nor fundamentally different. The differences are in degree not in kind.

—*Karl Pearson*

AN ECONOMIC ANALYSIS OF AGRICULTURAL LOANS GRANTED BY RURAL BANKS IN LUZON [1]

LEOPOLDO P. DE GUZMAN

The Rural Banks, which were created to provide for the normal credit needs of small farmers, extended 60 per cent of the 177 farmer loans studied to landowners.

The average amount extended to farmers was ₱392, or 87 per cent of what was requested. The 23 nonfarmers studied, who were mostly employees, received an average of ₱181, or 93 per cent of what they applied for.

Farmer loans had an average maturity of eight months and nonfarmer loans, five months. One-fifth of the total value of the loans was for the purchase of carabaos. The size of the loan granted was small in proportion to the security and sources of repayment, notably among the small loans. There was a tendency to favor the large loan applicants, who were mostly landlords.

This study was undertaken to get a cross-section of the farm loan services of 13 Rural Banks in Luzon during their first year of operation. Included in the survey were the characteristics of the loans as related to the characteristics of the farms and the applicants.

The banks included in the study were the Farmers' Rural Bank and the Rural Banks of Tayug, Kaluyagan, Angeles, Rodriguez, Liamzon, Novaliches, Imus, Ortanez, Santiago, Canlubang, Malolos, and Lilio. Every twelfth agricultural loan which was listed on the verification sheets of the Rural Banks was picked out to make up a sample of 200 loans. Information on the 200 borrowers was obtained from the Department of Loans and Credit and Rural Bank Administration of the Central Bank of the Philippines.

The 200 borrowers were classified into 177 farmers and 23 nonfarmers. The farmers' loans were subdivided into three classes:

small loans	₱ 40 to ₱ 150
medium loans	200 to 300
large loans	350 to 4,500

[1] Central Experiment Station Contribution No. 1882.

CHARACTERISTICS OF FARMERS

Age. The application forms contained no data about the age of the borrowers. Age affects the borrower's labor earnings and his ability to pay. Rivera and McMillan found that farmers with borrowings fully repaid were 39 years old on the average, whereas those with borrowings wholly unpaid were 51 years old.[2] The age of the applicant should be considered in granting loans.

Debts. Only nine farmers reported having an outstanding debt at the time of application for the loan. Their average debt was ₱838. Rural Bank loans of the same nine applicants averaged ₱756 per person. All of the nine borrowers were landowners.

Children. Only 152 farmers reported the number of their children in the household. The small loan holders had an average of 2 children per farm; medium loan holders had 3; and large loan holders had 2.

CHARACTERISTICS OF FARMS

Size. The average size of farm of the small borrowers was 3.7 hectares; of the medium loan borrowers, 5.2 hectares; and of the large loan borrowers, 8.2 hectares. The over-all average for all borrowers was 5.7 hectares. This is considerably above the average farm size of 2.9 hectares in the Luzon provinces where the banks are located. It would seem that the Rural Banks tended to meet the credit needs of the larger farmers and not those of the small farmers who particularly needed credit help. Lending to larger farmers is good business practice for the bank.

Tenure. Of the 177 farmer borrowers, 15 did not indicate their tenure status. Of those who reported, the majority, 60 per cent, were landowners. The tenants were only 29 per cent of the total number, or about one-half the number of the landowners, probably because of their nonownership of land. Land was an important item of security for the loans.

Crop division. Seventy-six of the 98 farmers who reported sharing their crops used the 50-50 ratio of crop division. Thirteen farmers used the 55-45 ratio, with the tenant getting the bigger share. There were other sharing ratios reported, each depending on the obligations of the contracting parties.

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[2] Generoso F. Rivera and Robert T. McMillan, "The Rural Philippines," Manila, 1952, pp. 103-104.

NATURE OF LOANS GRANTED

Amount. The size of the loans granted to farmers averaged ₱392, which was 87 per cent of the amount applied for (table 1). Nonfarmers received an average of ₱181, or 93 per cent of the amount applied for. The difference in proportion granted is explained by the difference in risks. The nonfarmers were mostly employees with a regular and fixed income. On the other hand, the farmers' income depended on the crops they raised.

TABLE 1.—*Average size of loans applied for and granted, 200 borrowers of Rural Banks in Luzon, 1953*

ITEM	FARMERS	NONFARMERS
Amount applied for	₱450	₱195
Amount granted	392	181
Percentage granted	87	93

The nonfarm loans ranged from ₱50 to ₱600. For farm loans the range was from ₱40 to ₱4,500.

Purpose. Nineteen per cent of the total value of the loans applied for by the farmers was for the purchase of carabaos, and 16 per cent was for the planting of crops (table 2). Among the nonfarmers, 57 per cent of the total value of the loans applied for was for poultry raising, and 23 per cent was for hog raising. Other purposes reported by nonfarmers were for expenses for fish ponds, fishing, and fencing.

TABLE 2.—*Purpose of loans, 173 farmers*

PURPOSE	SIZE OF LOAN						TOTAL
	Small		Medium		Large		
	Value	Per cent	Value	Per cent	Value	Per cent	Per cent
Purchase of carabao	₱ 13	8	₱114	36	₱134	16	19
Planting	47	27	54	17	113	13	16
Land preparation	23	13	24	8	109	13	12
Land improvement	13	8	41	13	99	11	11
Family expenses	41	24	18	6	64	7	9
Livestock raising	2	1	22	7	68	8	7
Seeds and fertilizer	11	6	11	4	45	5	5
Purchase of equipment	8	5	4	1	60	7	5
Miscellaneous	15	8	26	8	173	20	16
Total	₱173	100	₱314	100	₱865	100	100

About 24 per cent of the small farmer loans were for family expenses. Only 6 per cent of the medium loans and 7 per cent of the large loans were for family expenses. Rivera and McMillan stated that the tendency of the small farmer to spend most of his loan on consumption needs makes him a poor credit risk.[3] The low percentage of family expenses in the medium and large loans could be why the Rural Banks extended more credit to landowners.

Release schedule. No release schedules of the loans were reported among the borrowers. After approval the loans were released in one payment. The Rural Banks could give the loan in installments to the borrower or to his suppliers if the loan were 70 per cent of the value of the current crop.

Security. Of the 177 farmers studied, 17 did not report the value of their loan security. Among those who reported, the average value of security was ₱1,486.

For the medium and large loans, real estate represented four-fifths of the total value of the security per borrower (table 3). It was two-thirds for the small loans. The other items of security were of little importance.

TABLE 3.—*Relation of size of loan and security offered, 160 farmers*

SECURITY	SIZE OF LOAN					
	Small		Medium		Large	
	Average value	Per cent	Average value	Per cent	Average value	Per cent
Real estate	₱278	64	₱1,147	82	₱2,258	86
Salary	60	14	86	6	85	3
Animals	53	12	75	5	5	[a]
Implements	—	—	6	1	215	9
Crop	38	9	88	6	—	—
Miscellaneous	4	1	—	—	48	2
Total	₱433	100	₱1,402	100	₱2,611	100

[a] Value less than ₱1.

Real estate was important not only in proportion to total value of security but also in terms of the number of farmers offering it. It was offered as security by a total of 135 farmers, or 73 per cent of the small loan applicants, 84 per cent of the medium loan applicants, and 96 per cent of the large loan applicants.

[3] Rivera and McMillan, *op. cit.*

Endorsement of the loan by a co-maker was reported by 113 farmers.

The high percentage of loans secured by real estate tends to show that the Rural Banks failed to meet the credit needs of the small farmers who did not own enough security. To serve the small farmers who are mostly tenants, the Rural Banks should use chattel mortgages on equipment and livestock.

Ownership of livestock and equipment affects loan payments. The number of inspectors' reports on the livestock, equipment, and supplies of the borrowers was inadequate for use in this study. Most of the income statements of the nonfarm loans were not filled out.

Whether pledged or not, produce can serve as assurance of loan repayment. Some of the applicants stored a part of their produce for the use of the family and a part for the market. Palay made up 80 per cent of the average value of the products kept on hand by the farmer. The average value of these products was ₱202 for the small loan applicants and ₱430 for the large loan applicants (table 4).

TABLE 4.—*Values per farm of the products kept on hand, 111 borrowers*

PRODUCT	SIZE OF LOAN		
	Small	Medium	Large
Palay	₱178	₱290	₱339
Corn	10	46	22
Sugar	—	—	6
Coconut	1	4	32
Poultry	—	—	1
Others	13	32	30
Total	₱202	₱372	₱430

Terms. Loans to farmers were made for longer periods than those to nonfarmers (table 5). This policy is based on the fact that the farmer has to wait for his crops to grow before he can pay his debts.

TABLE 5.—*Maturity of 200 Rural Bank loans*

ITEM	AVERAGE PER LOAN	
	Farmers	Nonfarmers
Months applied for	10	6
Months granted	8	5
Percentage granted	80	83

Sources of repayment. The principal sources of funds from which farmers were expected to repay loans were the sale of palay, sugar, and other crops, the sale of livestock, and salaries. By far the most important of these was the sale of palay (table 6). It made up 47 per cent of the average of the sources of repayment and 71 per cent of the expected repayment funds of small loan holders.

TABLE 6.—*Sources of repayment of 147 farmer-borrowers*

SOURCE	SIZE OF LOAN					
	Small		Medium		Large	
	Average value	Per cent	Average value	Per cent	Average value	Per cent
Palay	₱200	71	₱153	27	₱ 891	50
Salary	35	13	168	29	170	10
Other crops	30	11	114	20	220	12
Sugar	3	1	67	12	170	10
Livestock	[a]	[a]	12	2	2	[a]
Coconut	—	—	—	—	11	1
Corn	—	—	1	[a]	4	[a]
Others	11	4	57	10	304	17
Total	₱279	100	₱572	100	₱1,172	100

[a] Value less than 1.

Although lending agencies must protect their loans by requiring adequate security, in the final analysis they are primarily interested in getting the loans repaid with interest. Farmer-borrowers usually must do this out of their net income.

The large loan holders had about three and one-half times as much net income available for debt service as the small loan borrowers (table 7).

TABLE 7.—*Net farm income per farm according to size of loan, 166 farmers*

SIZE OF LOAN	GROSS INCOME	EXPENSES	NET INCOME
Small	₱1,407	₱ 759	₱ 648
Medium	2,348	1,117	1,231
Large	3,907	1,609	2,298
Average	₱2,545	₱1,162	₱1,383

Nonfarm income can also be a source of loan repayment. Seventy-five farmers had no employment before they took up farming;

about 50 farmers were previously employed. Main sources of nonfarm income reported by 58 farmers were salaries, business gains, and pensions. Thirty-six farmers received nonfarm income from their off-farm work (table 8).

TABLE 8.—*Sources of nonfarm income of 68 farmers with nonfarm employment*

SOURCE	FARMERS						TOTAL
	Small loans		Medium loans		Large loans		
	Number	Per cent	Number	Per cent	Number	Per cent	Per cent
Employment	14	61	11	50	11	47	53
Business	6	26	7	32	8	35	31
Pension	2	9	2	9	2	9	9
Other	1	4	2	9	2	9	7
Total	23	100	22	100	23	100	100

Loan charges. The ordinary rate of interest charged was 12 per cent per annum. Four loans had an interest rate of 10 per cent per annum. Besides the interest which was deducted from the amount of the loan, the borrower had to pay inspection and /or miscellaneous fees (table 9). Notarial fees were not common since Rural Banks can use the services of Justices of the Peace without cost for loans of less than ₱2,000.

Fees other than interest increased with the size of the loan but represented a smaller rate of cost of lending. The fees charged on the small loans were 2.5 per cent of the average size; on the medium loans, 1.6 per cent; and on the large loans, 0.9 per cent.

TABLE 9.—*Average cost per loan, 165 farmers*

FEE	SMALL LOANS	MEDIUM LOANS	LARGE LOANS
Inspection fees	₱2.1	₱2.8	₱4.5
Notarial fee	0	0.2	0.2
Miscellaneous	0.5	1.1	2.5
Total	₱2.6	₱4.1	₱7.2
Percentage of cost to average size of loan	2.5	1.6	0.9

ANALYSIS OF THE LENDING

Amount requested and size of loans. The small loan applicants received 70 per cent of the amount they applied for; the medium loan applicants, 78 per cent; and the large loan applicants, 93 per

cent (table 10). The variation shows that the Rural Banks tended to favor the large loan holders, who were mostly landowners, by lending them more of the amount requested.

TABLE 10.—*Relation of loan granted to amount requested, 177 farmer-borrowers*

SIZE OF LOAN	AMOUNT REQUESTED	LOAN GRANTED	PERCENTAGE GRANTED
Small	₱148	₱103	70
Medium	314	244	78
Large	894	835	93
Average	₱450	₱392	87

Tenure and lending policy. As previously noted, landowners received the majority of the loans in the area studied (table 11).

TABLE 11.—*Loan distribution according to tenure, 162 farmers*

TENURE	SIZE OF LOAN						TOTAL
	Small		Medium		Large		
	Number	Per cent	Number	Per cent	Number	Per cent	Per cent
Landowner	20	36	33	61	44	83	60
Tenant	24	44	16	30	7	13	29
Owner-operator	11	20	5	9	2	4	11
Total	55	100	54	100	53	100	100

Considering that 55 per cent of the farmers in the provinces where the Rural Banks operate are tenants, the Rural Banks did a poor job of reaching the farmers whom they were intended to help. It is also significant that the medium and large loans were given mostly to landowners. Only in the small loans did the tenants get a proportion comparable to that of the landholders.

Security requirements and lending policy. The average size of the loans was only 26 per cent of the average security offered (table 12). The loans granted were only a fraction of the security pledged. There was some tendency to favor the large borrowers by lending them more in relation to their security.

TABLE 12.—*Size of loan in relation to security offered, 160 farmers*

SIZE OF LOAN	VALUE OF SECURITY OFFERED	LOAN IN PER CENT OF SECURITY
Small	₱ 433	24
Medium	1,402	17
Large	2,611	32
Average	₱1,486	26

Repayment sources and lending policy. Of the 177 farmers, 30 d not indicate their sources of repayment. Among those report- ıg, the average value of the loans given was 44 per cent of the aver- ge value of their sources of repayment (table 13). The expected epayment funds of the small loan borrowers were equal to one-half : those of the medium loan borrowers and one-sixth of those of the rge loan borrowers.

ABLE 13.—*Size of loan in relation to repayment funds, 147 farmer-borrowers*

SIZE OF LOAN	AMOUNT AVAILABLE FOR REPAYMENT	LOAN IN PER CENT OF REPAYMENT FUNDS
Small	₱ 279	36
Medium	572	43
Large	1,772	46
Average	831	44

Share of the crop and lending policy. The average size of the oan was related to the value of the borrower's share of the farm roduce. The average size of 177 farmers' loans was ₱392 and was 8 per cent of the value of the farmers' share in the farm produce table 14). The variation in size of the loan as related to the bor- ower's share of the crop again shows that Rural Banks gave more reference to landowners than to tenants who needed the loans most.

ABLE 14.—*Relation of size of loan to borrower's share of the crop, 177 farmers*

SIZE OF LOAN	SHARE OF CROP	LOAN IN PER CENT OF SHARE OF CROP
Small	₱ 921	11
Medium	1,267	19
Large	2,120	40
Average	₱1,438	28

RECOMMENDATION

It is recommended that the application forms be properly ac- omplished so that a good picture of the borrower and his business nay be obtained. A sound appraisal of the assets of the farmer is ıecessary in determining his capacity to repay his loan.

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ERRATA

Page 59, line 8 of abstract, for "About 61 per cent" read "About 62 per cent."
Page 59, line 13 of abstract, for "about 64 per cent" read about 61 per cent."
Page 61, line 5, for "Breeding stock" read "Butcher stock."
Page 61, line 7, for "About 73 per cent" read "About 71 per cent."
Page 62, line 11, for "Others tied their hogs near the house" read "Others tied their hogs near the house, pastured them, or used a combination of the different methods."
Page 62, line 4 from bottom, for "by about 61 per cent" read "by about 62 per cent."
Page 65, last line, for "93 per cent of the pigs" read "94 per cent of the pigs."
Page 66, line 7 from bottom, for "about 33 per cent" read "about 53 per cent."
Page 79, line 3 from top, for "1/2 — 2/3" read "1/3 — 2/3."
Page 133, last line, for "Cendaña (1940)" read "Cendaña (1949)."
Page 152, first line, for "farmers' Cooperative Marketing Associations" read "Farmers' Cooperative Marketing Associations."
Page 318, line 20 from top, for "0.4 cm. to more than 1.0 cm." read "0.4 cm. to more than 10.0 cm."
Page 327, line 17 from bottom, for "49 hours" read "48 hours."
Page 328, line 17 from top, for "the soil was infected" read "the soil was infested."
Page 328, line 5 from bottom, for "eight pots of soil" read "eight-inch pots of soil."
Page 366, table 2, interchange "irrigated" and "nonirrigated."
Page 377, line 9 from bottom, for "*Proutesta moesta* Westwood" read "*Proutista moesta* Westwood."
Page 385, line 18 from top, for "*Matthiola incena*, R. Br. var. annua" read "*Matthiola incana* R. Br. var. *annua*."
Page 422, lines 10 and 20 from bottom, and page 427, first line, for "*Aphis brassicae* Linn." read "*Rhopalosiphum pseudobrassicae* (Davis)."
Page 429, line 6, for "₱1,248 per farm" read "₱1,249 per farm."
Page 497, line 3, for "average area of 0.9 hectare" read "average area of 0.9 hectare planted to pineapple."
Page 505, line 9 from bottom, for "in 1917" read "in 1947."
Page 512, line 4 from bottom, for "34 were for less than 3 months" read "34 per cent were for less than 3 months."
Page 514, line 15, for "28 did not state" read "18 did not state."
Page 529, line 19 from bottom, for "10 × 4 hills" read "4 × 10 hills."
Page 558 through 570, for "Brondal Poetich" read "Brondol Putih," and for "Tjahaya" read "Tjahaja."
Page 562, line 5 from bottom, for "soil and germination conditions" read "soil and germinator conditions."
Page 612, footnote 2, for Generoso F. Rivera and Robert T. McMillan, "The Rural Philippines," Manila, 1952," read "Generoso F. Rivera and Robert T. McMillan, "An economic and social survey of rural households in Central Luzon," Manila, 1954."

63/2 Root-